THE TECH ENGINEERING NEWS

MEMBER OF THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

MASSACHUSETTS
INSTITUTE OF
TECHNOLOGY

VOLUME X, NO. 3
APRIL, 1929

A New Source of **POWER**..

The continued industrial expansion of America depends, in a large measure, upon the availability of an ample supply of cheap power.

A most efficient Industrial Steam Cycle is coming into use; a cycle which through the use of high initial steam pressures provides a source of cheap power for any plant using steam for processing.

There has been a definite trend toward the adoption of higher steam pressures in the Public Utility field. Our intimate identification with this development led to the realization that the use of high pressures could be advantageously extended to Industrial plants by generating steam at a pressure sufficiently high to develop the amount of power required, when the turbines or engines are exhausting at a pressure high enough to meet the steam needs for process work. The prime movers thus act as reducing valves and the steam serves a double purpose in its reduction from initial pressure to final exhaust pressure.

The cycle is simple, dependable and economical.

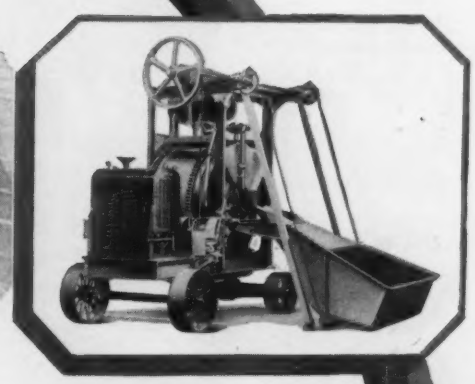
Several installations of this type are already in successful operation. Several more are designed and in course of construction.

This Company has developed, manufactured and installed all types of steam generating equipment covering a wide range of pressures up to 1400 lb. per square inch —and, we are now building units to operate at 1800 lb. pressure. This will be the highest steam pressure in commercial use in America and the plant in which these units are being installed, will be the largest steam plant in the world operating at such a pressure.

The use of high pressures involves many engineering problems which necessitate close coordination of fuel burning and steam generating equipment. As pioneers in the development of complete steam generating units—both stoker and pulverized fuel fired types—Combustion Engineering Corporation is in a position to give valuable counsel to those interested in the economies of high pressure steam.

COMBUSTION ENGINEERING CORPORATION
International Combustion Bldg., 200 Madison Ave., N. Y.
A Subsidiary of
INTERNATIONAL COMBUSTION ENGINEERING CORPORATION

BUILT ON DOMINANT STRENGTH CONCRETE



Thirty-three stories, the Southwestern Bell Telephone building in Saint Louis towers above the street level. It is the tallest structure in the city and one of the strongest.

Typically American the walls of this imposing building rise in steps called the "set-back" style in construction. On one side of the building the steps occur at the 13th, 17th, 20th and 23rd floors while on two other sides they occur at the 15th, 22nd and 25th floors.

Unseen, yet of great importance, is the foundation. Here, as on many large building projects throughout the world, a Koehring Heavy Duty mixer with its re-mixing action turned aggregate and cement into dominant strength concrete caissons. Reaching 75 feet below street level, 130 of these reinforced columns support the Telephone building.

Koehring re-mixed concrete is dominant strength concrete.

"Concrete—Its Manufacture and Use," a complete treatise and handbook on present methods of preparing and handling portland cement concrete, will be gladly sent on request to engineering students, faculty members and others interested.

KOEHRING COMPANY
MILWAUKEE, WISCONSIN
Manufacturers of
Pavers, Mixers—Gasoline Shovels, Pull Shovels, Cranes and Draglines
Division of National Equipment Corporation

KOEHRING HEAVY DUTY

KOEHRING

LEAD ' ' The dependable metal

Modern life calls for convenience. It also calls for a show of beauty. But what are these values worth if beneath them there is not a solid foundation of endurance, of *dependability*? Lead has stood the test of dependability for many centuries. It stands today as the plumber's great ally in giving long lasting satisfaction and service. For lead is tough, elastic, withstanding shocks and disturbances that break other metals. *The Eagle-Picher Lead Company, 134 North La Salle Street, Chicago.*

EAGLE ' ' ' Pipe ' Fittings ' Solder

THE TECH ENGINEERING NEWS

Volume X — CAMBRIDGE, MASS., APRIL, 1929 — Number 3

Copyright 1929 by The Tech Engineering News

Entered as second class matter, June 1, 1920, at the Post Office at Boston, Mass., under the Act of March 3, 1879.
Acceptance for mailing at special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized November 3, 1920.
Published monthly throughout the school year by the undergraduates of the Massachusetts Institute of Technology for the purpose of disseminating news of scientific and industrial interest and of promoting closer co-operation between Alumni and undergraduates.

THE MANAGING BOARD

HOWARD S. GARDNER, JR. '30, *Editor*
CHARLES C. LADD '30, *General Manager*
CHARLES F. EDLUND '30, *Business Manager*
CHRISTIAN E. GROSSER '31, *Managing Editor*
CHARLES R. WOOD '31, *Publicity Manager*
NELSON B. HASKELL '31, *Advertising Manager*
RICHARD T. KROPF '31, *Circulation Manager*
JOHN H. DODGE, JR. '31, *Associate Editor*
ANTHONY R. SAVINA '30, *Treasurer*

EDITORIAL DEPARTMENT

CHARLES W. RANKIN '31 . . *Assistant Managing Editor*

EDITORIAL STAFF

E. H. ANDERSON '32
R. C. M. CALVERT '32
C. CHAYABONGSE '32
N. D. FITZGERALD '31
I. W. HILLIARD '32
H. G. PROTZE '32
W. F. SPREEN '32
A. G. STOCKWELL '32
T. HARPER, JR. '32

BUSINESS DEPARTMENT

GEORGE M. ORNE '31 . . . *Assistant Circulation Manager*
HERBERT E. RAYMOND, JR. '31 . . *Assistant Treasurer*

BUSINESS STAFF

F. S. CHAPLIN '32
D. W. BROOKFIELD '32
G. D. JOHNSON '32
J. E. LINZ '32
R. M. STEWART '32
E. A. NEWCOMB '32
K. J. HEINICKE '32
S. EDELSTEIN '32
P. P. SHELBY '32
A. M. MAGUIRE '32

THE ENGINEERING COLLEGE MAGAZINES ASSOCIATED

Chairman, Willard V. Merrihue, 1 River Road, Schenectady, N.Y.

The Transit
Iowa Engineer
Colorado Engineer
Nebraska Blue Print
Pennsylvania Triangle
Sibley Journal of Engineering
Purdue Engineer
Rose Technic
Michigan Technic
Ohio State Engineer
The Tech Engineering News
Wisconsin Engineer
Penn State Engineer
Technograph
Cornell Civil Engineer
Minnesota Techno-Log
Kansas State Engineer
Kansas Engineer
Princeton E. A. News Letter
Armour Engineer
Oregon State Technical Record

SUBSCRIPTION PER YEAR, $1.50
Address all communications to The Tech Engineering News, Walker Memorial, Cambridge 39, Massachusetts. Telephone, University 6864
Advertising rates upon application

TABLE OF CONTENTS

	Page
THE AMERICAN PETROLEUM INSTITUTE. By Leonard M. Fanning	89
OIL GEOLOGY AND PRODUCTION. By W. L. Whitehead '13	90
ENGINEERING AND M. I. T. By Samuel W. Stratton	92
TRAFFIC ENGINEERING. By Maxwell N. Halsey	93
OIL AND GAS WELL FIRES. By Ben E. Lindsly '05	94
SOUND MOVING PICTURES. By Edward O. Scriven '10	96
BEYOND THE CLASSROOM. By Lawrence C. Hamlin '29	98
EDITORIALS	99
THE ENGINEERING FIELD	100
DEPARTMENTAL NOTES	102
RECENT BOOKS	103

When You're Asked to Address A Gathering

SOME day you may be a leader in your community—the man to whom everyone turns when strong counsel is wanted. Already you may be on the road to a broader service—contributing your time and thought to extra-curriculum affairs—editing a paper, managing or playing on a team, doing social service work, acting for the dramatic club. Out of college the same opportunity for public service exists as in college. Men who are leaders in their business or profession are often leaders in civic affairs, too.

When you leave college you're going to meet Stone & Webster men. You'll find them taking an active part in the community—leading in civic affairs as they lead in their business. You'll find them managing transportation companies, operating and financing public utility companies and building industrial plants. You'll find the Stone & Webster organization is worth knowing and worth doing business with. The Stone & Webster training ably fits its men for public service.

STONE & WEBSTER
INCORPORATED

OPERATE FINANCE BUILD

APR 11 1929

© CIB 25088

THE TECH
ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME X APRIL, 1929 NUMBER 3

The American Petroleum Institute

An outstanding example of industrial coöperation and service

By LEONARD M. FANNING
Director of Public Relations
American Petroleum Institute

THE demands which have been made upon the oil industry by the voracious consumer are past belief. In ten years there has been an increase of over 17,000,000 in the number of automobiles registered in the United States. At present there are 24,750,000 motor vehicles running on the streets and highways of this country. No deft magic can explain the achievement of the oil industry in meeting the gasoline demand in the last ten years. The oil industry had to work to find and make oil products. It continued a search for petroleum deposits on a constantly expanding scale. This involved vastly increasing financial burdens, and the industry called to its service scientific and engineering thought that has virtually revolutionized production practice. The last ten years have seen the greatest expansion in exploration and production of petroleum, not only in this country but throughout the world, of any decade since Drake drilled his famous well near Titusville, Pa., in 1859.

Not only has the oil industry supplied the fuel and lubrication for the multiplying motor car, but it has done even more in making the motor car so prevalent with all this implies in social advancement. Gasoline has built thousands of miles of roads. And no less amazing than the growth of the automobile is the equipment of this continent with modern roads in a comparatively few years. Revenues from state gasoline taxes have been a very vital factor, and the gasoline tax is now one of the most important sources of highway revenue, its yield representing about one-fourth of the total of all funds available for road purposes.

Gasoline has been the most important product of petroleum from the standpoint of consumption during the last decade. But it should not be overlooked that other products of petroleum share with gasoline that vital position in modern civilization that comes with universality of usefulness. Herein lies the magic of petroleum — in its service for light, heat, power, lubrication, medicine, and what not.

Ten years ago the American Petroleum Institute was formed as an outgrowth of the National War Service Committee. It is an association of more than four thousand persons engaged in the oil and allied industries, and it has held an increasingly important position in the oil industry in connection with its coöperative activities on such problems as accounting and taxation, standardization, development and production engineering, technology, statistics, and public relations.

One of the most valuable lessons resulting from the World War was that of the benefits derived from organizations embracing the entire scope of a basic industry. The American Petroleum Institute is one of these bodies, and, in its many and varied activities, it is performing increasingly important functions.

One of the most important matters which has held the attention of the Institute is that of conservation; and through committees it has coöperated with the Federal Oil Conservation Board appointed by President Coolidge in 1924.

Recently, through the Institute, country wide committees were organized to formulate a national petroleum industry code of ethics to apply to the marketing of petroleum products. The code resulting is now before the Federal Trade Commission for approval, and will probably be generally adopted throughout the industry.

Work on uniform accounting, for the adoption of oil companies, began under the auspices of the Institute four years ago. As a result of intensive coöperative work, a uniform balance sheet and income account have been adopted by the oil companies.

Great progress has been made in standardizing oil field equipment and methods through the Standardization Division of the Institute. Specifications have been completed on 90 per cent of the equipment used in the drilling and producing of oil.

At the annual meeting of the Institute, held in Chicago in 1927, a Division of Development and Production Engineering was established, and subsequently this division has been organized throughout the oil producing districts. The primary objective of the division is the collection, correlation, and dissemination within the industry of information both technical and practical concerning development and production technique. The dissemination of this information is through regional meetings and through open session meetings of the American Petroleum Institute and through the official publications of the Institute.

The petroleum industry, which has grown to its great magnitude from an inadequate foundation of fundamental knowledge regarding the raw material on which it rests, has embarked on a research program designed to assist in

(*Continued on page 104*)

Oil Geology and Production

The occurrences and characteristics of petroleum deposits, and their relation to their development of the industry

By W. L. WHITEHEAD '13
Special Lecturer in the Geology of Coal and Petroleum
Massachusetts Institute of Technology

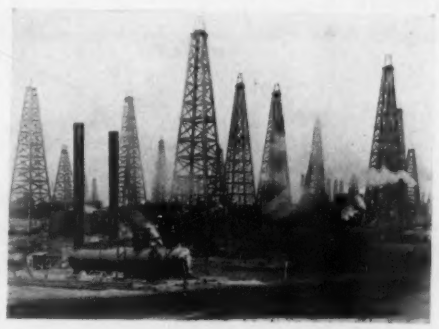
IN the present period of great production of petroleum, it is interesting to look back through the perspective of time to the days of the pioneers when "rock oil," procured four hundred feet below the earth's surface, was "a wonderful natural remedy" and to review the eighty years' progress of the industry extracting 2,600,000 barrels of petroleum daily from wells as deep as 8,500 feet in the United States today. In this three-quarters of a century, the raw material, crude oil, has changed from the commodity of the itinerant peddler to the basic material of one of our greatest industries. The extraordinary and complex properties of the substance have been discovered and used; the occurrence and geologic origin of oil have been studied in many lands, and knowledge of the finding of petroleum has been developed to an extent that, in spite of our great needs, we have now more crude oil than we can use.

This growth has not been fortuitous; for accompanying the development of the petroleum industry and both causing it and being inspired by the available raw material, a series of inventions has occurred. Kerosene lamps were new in 1876 when nine million barrels of oil came almost entirely from Pennsylvania, but lamp oil and lubricants offered little further expansion in 1901 when sixty million barrels of crude oil still came principally from the Appalachian states. The internal combustion engine, however, had at this time been invented, automobiles were being produced and the airplane was almost ready for controlled flight. In the next five years the production of petroleum had more than doubled, California became the principal field with Oklahoma and Illinois close behind, and Texas had begun her long effort towards preëminence. More recent history is concerned with development rather than with new invention, although further outlets for petroleum products are continually being found; but in each ten years since 1908 our oil production has again been doubled, until today the known supplies of petroleum under the surface of the United States are sufficient for the yearly projected needs of, our country almost ten years hence.

A GUSHER IN FULL FLOW

The two great periods of petroleum expansion, from 1850 to 1875 and from 1902 to 1908, were caused by inventions which were quickly adopted by the American people and in the broader field by those of the world. At these times new fields were available, first in the regions extending about Pennsylvania, next in California and in the great area of the Midcontinent. But in less spectacular times the steady and often rapid growth of oil demand required additions to the knowledge of oil occurrence. It is this development that is the principal cause of present conditions.

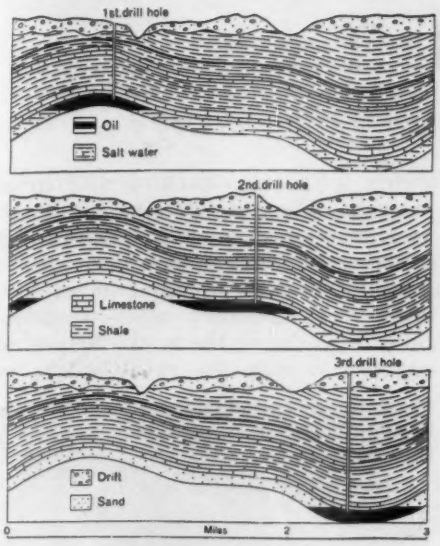
In 1859 when Colonel Drake drilled 69 feet at Titusville, Pennsylvania, to bring in the first oil well in the United States, it is probable that his only reason for the undertaking was a belief that seepages of petroleum along Oil Creek were fed from underground sources. His idea was correct and for a time wells were drilled in similar situations, but as seepages were rare in Pennsylvania operators ventured farther and farther away from them until it was established that sources of oil existed where no indication appeared at the surface. At this time certain trends of oil pools were discovered; the oil followed northeasterly lines, and drilling proceeded on these lines to the best advantage. It was also found that usually the drill reached gas first, then oil, and that after producing oil, a well would flow water. These relations and the fact that the oil was found in northeasterly folded, coarse, porous sandstones and oftenest on the tops of arched folds, caused Dr. I. C. White, in 1885, to propose that on these arches or anticlines, due to gravity, the oil floated on the water saturating the sandstones, and that the gas lay above the oil. This anticlinal theory persisted through many vicissitudes, for, though



A MODERN OIL FIELD
The derricks are of steel construction, in contrast with the wood frameworks of early years

it met with much opposition from those who drilled dry holes on arches in the Appalachian rocks, upon further study variations of sandstone porosity were found to be important, and it was discovered that a seal or impervious cap to the sandstone bed was needed. The cap rock effectually prevented the pressure on the gas and oil from causing their diffusion from the porous sandstone. In Pennsylvania it is usually a dark colored shale or fine-grained mudstone.

In the meantime Newberry, another geologist, had noticed these shales in their association with oil from a different standpoint. He found that in Pennsylvania the sandstone beds, where they appeared at the surface, were usually interbedded with dark shales which contained many organic remains, both vegetable and animal, in the form of fossils. He stated his belief that the vegetable organisms had decomposed and, in the long period of geologic time, had been converted to petroleum. As the shales or mud-like rocks contained the organisms while the sandstones in which the oil was found were barren of such remains, the oil had necessarily migrated from the shales into the sandstones. But about this time, 1886, Ohio had begun to produce oil from another rock formation. Oil here came from a porous limestone in which many shells of animal fossils were found. It was therefore proposed that the petroleum was derived solely from animal remains.



TYPICAL OIL POOLS
The above sections show the relation of oil accumulation to geologic structure

The controversies regarding the anticlinal theory and whether petroleum came from the decomposition of animal or vegetable matter persisted throughout the closing years of the last century. New discoveries of oil in West Virginia, California and Indiana had met the slowly increasing demand and further information from geologists was not greatly needed by oil operators. The tendency continued to look for oil on the tops of arches in sandstone and shale formations, or in porous limestone beds and to interpret, as best might be, the possible porosity of the beds penetrated some 1,500 feet below the surface.

In 1901, coincident with the early automobile production, occurred an event of great significance in the history of the American petroleum industry. On the Gulf Coast, a mining engineer, Capt. Anthony Lucas, had drilled some wells for Joseph Jefferson, the actor, and had found salt. He was interested in certain indications of petroleum connected with the salt wells and in 1900 began a well at Spindletop, Texas to test this locality for oil. Many difficulties were encountered as the formation to be penetrated contained quicksands. Three previous wells had failed and even Lucas, who first used here the rotary system of drilling in place of the older standard cable percussion method, lost his first well. The second attempt, however, was successful, and in January, 1901 at 1,140 feet he brought in a tremendous gusher. The early flow is unknown and is estimated at from 75,000 to 100,000 barrels per day, the greatest oil well the world had yet seen.

The consequences of the Spindletop discovery were far reaching. A new system of drilling, well adapted to soft rocks and continuous in contrast to the older intermittent process, had been devised. Oil had been discovered in larger quantities than ever before and in relation to salt bodies quite different to the former occurrences in sandstones and limestones. A new region was opened that today in Texas and Louisiana produces nearly 50 million barrels of crude yearly. Geologists realized that their former knowledge was incomplete; producers saw rich new fields to meet the quickly growing demand; and competition was stimulated by the new companies of Texas. The industry woke up.

At this period Russia had been dominant in petroleum production for several years. Her fields, somewhat similar to those of California, had attracted considerable attention from geologists, but as the interest was, in a great degree, foreign to American companies, little was known in the United States of these fields or of those of the East Indies. Nearer home, however, in Mexico, oil was being found, and between 1907 and 1910 began the great flood of Mexican petroleum. American geologists joined the hunt for oil in Mexico and it soon developed that the petroleum occurred near the plugs of the vents of old volcanoes. By 1913 the occurrence of oil was recognized to be a complex and variable thing. It was seen that porous rocks or rocks containing cavities of any kind offered reservoirs for oil floating on a water surface.

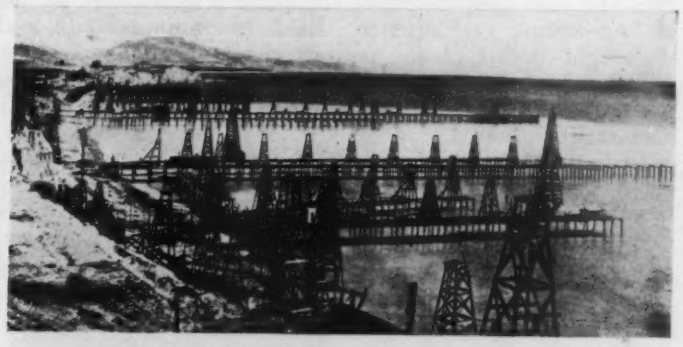
In the meantime the folds of Oklahoma had been exploited. Forty to fifty million barrels a year testified to the applicability of the anticlinal theory in the region and still further advance had been made in the development of the theories of the origin of petroleum. Experiments combined with the proved relations of oil to shales and mud rocks containing vegetable remains had offered incontrovertible evidence of the derivation of the oil from vegetation. Animal remains of microscopic size in the rocks of California had given indications of equal weight of the organic animal origin of the oil there. So a truce was drawn, and both types of organisms are accepted today as having contributed to the oil supply.

Petroleum, however, is found in the porous rocks, and but little bituminous matter remains in the shales. The method of migration of the petroleum produced from organisms in prolonged reactions by heat and pressure in the fine mud rocks had remained unexplained.

Washburne in 1912 furnished the answer. The surface tension of water is about three times that of oil and, therefore, in the small capillary openings in the mud rocks considerable forces would tend to replace the oil by water in a saturated rock. This oil escaping into the more porous sandstones would be distributed by gravity or other forces to a position of equilibrium at the water gas surface on the arches or other porous high sealed points. In dry rocks the oil would descend into basins. The reservoirs were then known to be in sandstones, in porous limestones, and in fractures near salt bodies and old volcanoes.

Geologists had now discovered sufficient information regarding the occurrence of petroleum to be of more service to the producer. The larger companies added departments of geology to their staffs and intensive work upon the surface of the oil-producing states began in a search for folded arches or, along the Gulf Coast, for indications of salt domes.

The search was successful. Oklahoma, Kansas, Louisiana, Texas and California saw unprecedented development. The fields of Wyoming and Montana were discovered. Mexico, in 1921, reached her peak production, while the United States doubled the output of 1912. The geological knowledge of oil occurrence was proved an effective tool in practical affairs. The anticlinal theory was fully established, but with the many and complex modifications inherent to a simple theory explaining the varied manifestations of nature.



THE SUMMERLAND FIELD, SANTA BARBARA
With the wells sunk beyond the shore line, this represents an interesting development in drilling

Abroad also, the geologist, and in many places the American, in foreign service, found oil. The smaller fields of Trinidad, Egypt and Argentina were developed. Petroleum was produced from Persia and the oil fields of Venezuela and Colombia were discovered.

In these years, from 1912 to 1921, the knowledge of oil fields had been extended and amplified. Many new

(*Continued on page 118*)

Engineering and M. I. T.

The engineering professions and their presentation at Technology

By SAMUEL W. STRATTON
President
Massachusetts Institute of Technology

SINCE time immemorial the engineer has been one of the most dominant and progressive forces in the scheme of our existence. He has fittingly been called the "world's greatest civilizer." He has been the wheel which has balanced the discoveries of the experimenters and the pure scientists with the economic life of the world. The turning of the fundamental physical and chemical principles to practical account by these men has, in the main, made our modern civilization possible.

Today the physical pioneering is to a large extent finished. The far places of the earth have been mapped and explored; the great transportation systems, the radio, and the airplane are bearing the torch of commercial progress into all the inhabited parts of the globe. But a greater task lies just ahead. The increasing complexity of the problems that the machine age and the growth of population bring will make heavier and more exacting demands upon the scientist and the engineer. Great water supply systems are built, used and rendered obsolete within a few years, so rapid is the growth of population in certain urban centers. Newer and bolder visions must be conceived and made to serve. These great problems which loom in the future have possibilities for benefiting mankind which are limited only by the vision of the men who must solve them. Widely differing types of men can find their places in the fields of engineering and science. Each is important in his place, and all contribute equally to the finished product, whether it be a bridge, a machine or a chemical compound.

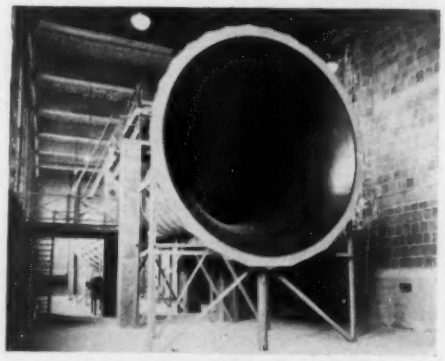
In the calibre of its staff, in the inclusiveness and modernity of its equipment, and its coördinated and balanced curriculum, the Massachusetts Institute of Technology has the means of training men thoroughly and broadly in the fundamentals of science.

A wide range of subjects with general cultural values is incorporated into all the courses offered, including English and History, Economics, Foreign Languages, Literature, Music and Fine Arts.

Courses lead to the degree of Bachelor of Science in civil engineering, sanitary and municipal engineering, mechanical engineering, electrical engineering, mining engineering, metallurgy, chemical engineering, chemical engineering practice, electrochemical engineering, aeronautical engineering, general science, general engineering, mathematics, engineering administration, architectural engineering, naval architecture and marine engineering, building construction, physics, chemistry, biology and public health, industrial biology and geology. The five-year course in architecture leads to the degree of Bachelor in Architecture.

In each of these, sufficient options are offered to enable the student to make a selection which will qualify him to undertake work in new and special fields of technical and scientific endeavor, such as automotive engineering, highway engineering, fuel engineering, etc. These options also provide for the study of the science and technology of paper making, the refining of oils, and of the manufacture of rubber, leather, building and other materials. In addition the Institute offers may facilities for graduate work and gives courses leading to the degree of Master of Science, Master in Architecture, Doctor of Philosophy, Doctor of Science and Doctor of Public Health.

Civil Engineering, as it is understood today, is that branch of engineering which concerns itself chiefly with works of more or less permanent character required either for transportation by land or water; or for the collection, regulation and distribution of water for power and domestic uses and for irrigation; or for the removal of manufacturing and human wastes and of storm water; or for industrial and commercial projects. The duties of the civil engineer in connection with such works include location, design, supervision during construction, maintenance and, oftentimes, operation after construction. Included in the work of the civil engineer is also the investigation of the economic phases of proposed projects and the valuation of existing plants.



THE LARGE WIND TUNNEL
Much Army and commercial aeronautical research is carried on in this tube, 86 feet long

A CHEMIST IN THE LABORATORY OF APPLIED CHEMISTRY
At work on one of the studies of textile fabrics being made at M. I. T. for the purpose of solving some of the fundamental problems of laundering

The undergraduate course in Civil Engineering at the Institute is divided into three options: (1) General, (2) Transportation Engineering and (3) Hydroelectric Engineering. The students in all these options are given thorough training in the fundamental subjects underlying the practice of Civil Engineering, and a certain amount of special training in the particular field covered by the option.

The opportunities open to the recent graduate in Civil Engineering are numerous and constantly increasing with the development of this and other countries. The Institute offers a five-year course in Railroad Operation, the purpose of which is to provide fundamental training in engineering and practical operating experience in the various departments of a railroad.

Closely allied with present-day Civil Engineering, the course in Sanitary and Municipal Engineering concerns itself particularly with engineering problems bearing upon the public health. It differs from Civil Engineering in that the engineer in this field must have a considerable knowledge of biology, bacteriology and organic chemistry in addition to his knowledge of the fundamental civil engineering subjects.

Mechanical Engineering is one of the broadest of all fields of engineering. When James Watt discovered that

(*Continued on page 122*)

Traffic Engineering

Current activities by the Commonwealth of Massachusetts and the City of Boston

By MAXWELL N. HALSEY
Traffic Engineer for the
Commonwealth of Massachusetts

IN this age of increasing activity in the field of traffic engineering, the general public hears a great deal about the fact that something is being done, but very little about what is actually being accomplished. Since everyone is at one time or another either a pedestrian or a motorist, we are all very apt to become exceedingly impatient, particularly if we do not thoroughly understand the engineering aspects of the problem of street traffic control. It has taken the steady pressure of congestion to sell to the public the idea that street traffic regulation is an engineering problem and that engineering principles must be applied before changes for the better may be expected.

Growth of Traffic Engineering

In the early days of personal transportation by automobile, congestion was centralized in a comparatively few localities. The margin of movement and safety was sufficient to permit its control by guesswork or politics. As this great menace to transportation spread and became more acute, it was soon noticed that existing methods were of little use in solving the problem. The public and its servants stood for increasingly bad conditions for a much longer period of time than would have any private corporation, but at length even they were forced to see that steps must be taken to improve the situation.

The situation became most acute in municipalities, since they are usually established at the intersection of important highways, and it was in these places that the early engineering attempts were made. Various organizations have arisen to serve the pressing demand. The author has had the pleasure of being associated with one of these, the Albert Russel Erskine Bureau for Street Traffic Research. This bureau established at Harvard University has made surveys in Boston, Chicago, Los Angeles, San Francisco, Providence, New Orleans, and is now engaged in making a comprehensive survey for the Commonwealth of Massachusetts. Through these investigations a basis of facts is established from which engineering conclusions and recommendations may be made. In this way there are recorded facts and a history of experience from which many lessons may be drawn.

With the development of highways and the improvement of the automobile the length of the average trip has been increased materially. The problem has grown from its early localized status to one of much wider scope. Motoring has expanded from the limits of the city to and beyond those of the county and the state. Its control over larger areas must now be interconnected and made uniform.

Two of the most indicative traffic investigations in the country are taking place within the Commonwealth of Massachusetts. The Boston activity is of special interest because of the unusual character of the city streets and their traffic characteristics. The Massachusetts survey is of tremendous interest due to the fact that it represents a pioneering movement, probably the first state-wide survey of its kind. The following discussion is given in an attempt to furnish the public with two outstanding examples of what is being done in this comparatively new field of traffic engineering.

The importance of metropolitan street traffic control as an engineering problem is rapidly becoming recognized by the public at large. The growth of traffic in this day of the constantly increasing use of the motor car has brought it to a point where only the methods of science can efficiently cope with the situation. The author, Mr. Halsey, is a former Albert Russell Erskine Fellow of Harvard University and at present Traffic Engineer for the Commonwealth of Massachusetts. A pioneer in this new branch of engineering, he is in a position to give the most authoritative information on a subject which we feel will be of the greatest interest to all our readers.

The Boston Traffic Survey

The City of Boston, with its narrow streets and heavy vehicular and pedestrian traffic, has felt for some time the increasing pressure of congestion. Some years ago when the conflict of surface street cars with other vehicles and pedestrians became unbearable in the downtown district, they were moved underground and so Boston built one of the earliest subway systems in the country. The rapid growth in free-wheel transportation since that day has placed that city in another congested position which again demands relief. Public opinion crystalized in December, 1926, when the Honorable Malcolm E. Nichols, Mayor of Boston, called together a number of public officials and representatives of business organizations to consider the problem of street traffic congestion in the City of Boston. This group became the Mayor's Street Traffic Advisory Board and at one of its early meetings, reached the conclusion that a comprehensive survey of the problem should be immediately undertaken. The Board recommended that the Albert Russel Erskine Bureau for Street Traffic Research be invited to conduct this study and that an appropriation be made to defray the expense of the work. The Mayor approved of the recommendation, the City Council voted the appropriation, and the work began at once.

The survey received great assistance in addition to the appropriation of $25,000. A great many of the city departments offered men and materials, while civic organizations and business men aided by contributing men and taking counts at the survey's request. The gathering of all the facts representing the present condition, together with their analysis and the recommendations following therefrom consumed over a year's time. The findings and conclusions have been printed in report form and will serve as a base for future study.

*Survey Recommendations**

Among a list of recommendations on the part of the survey, the following are of interest. The purpose of the survey was the design of a balanced and coördinated system of traffic regulation; the principal specific conclusions were contained in a remodeled system of traffic rules and regulations. This code contained comprehensive and definite provisions for the regulation of various types of traffic movement, designed to replace rules which were at that time in force. Public hearings were held upon this proposed code, and it was passed practically as written. Of special interest is recommendation concerning traffic signals. A coördinated system of automatic signals was proposed for various parts of the city. The first unit is being installed at the present time, and in-

*These recommendations are to be found on pages 1 to 4 of "The Street Traffic Control Problem of Boston."

(*Continued on page 108*)

Oil and Gas Fires*

The causes, extinguishing and prevention of fires under field conditions

By BEN E. LINDSLY '05
Senior Petroleum Engineer
United States Bureau of Mines

OIL and gas well fires constitute one of the greatest hazards confronting oil operators. The recent well fires which occurred at Santa Fe Springs, Calif., are striking examples of the loss in property and natural resources and the danger to human lives caused by such fires. "The property destruction, together with the value of the oil and gas consumed, and the cost of extinguishing these two fires, is estimated at upwards of two million." † The first fire (Fig. 2) burned for seven weeks. When finally brought under control, the well produced at the rate of 6,000 barrels of oil and ten million cubic feet of gas daily. Estimates of its initial production, shortly after it blew itself in and caught fire, are as high as 10,000 barrels of oil and 40 million cubic feet of gas daily.

The second well, which was brought under control in three weeks, is reported to have produced at the rate of 2,500 barrels of oil and 30 million cubic feet of gas daily.

The general subject of cause, prevention and extinguishing of oil and gas well fires is complex. The following text is confined to brief accounts of a few outstanding examples of oil and gas well fires, and the methods used in combating them.

Well No. 17, Getty-Nordstrum Lease, Santa Fe Springs, Calif.,‡ "blew out" September 16, 1928, while drilling was in progress at a depth of 5,409 feet. A feverish attempt was being made to reach the prolific Buckbee zone which had been discovered a few weeks previously by another well at a depth of 5,650 feet. Circulation of mud fluid in the Getty-Nordstrum well had been lost while passing through the partly depleted Meyer zone, 700 to 1,200 feet above the Buckbee. During the drilling, an unexpected high-gas-pressure zone was drilled into. The column of mud fluid in the hole was insufficient to hold back the gas, and the well "blew wild," catching fire with a heavy explosion within half an hour after the initial flow. The fires under nearby boilers probably ignited the gas.

Possibly the common methods of setting off a charge of high explosives or directing steam jets near the base of the flame would have snuffed out the fire temporarily, but owing to the great mass of hot metal lying over the mouth of the well, probably it would have reignited immediately. Furthermore, it was wholly inadvisable to extinguish the fire until means had been prepared for handling the large production of oil and gas coming from the well. The burning well presented less menace to surrounding wells and other valuable property than if the fire had been extinguished, allowing oil and gas to flow uncontrolled. Such a condition might have resulted in a more disastrous fire with possible loss of life and great destruction of valuable property. This danger was so pronounced that a pilot burner was placed near the mouth of the well early in the operations.

The planning and execution of a method, whereby the production was controlled first and then the fire was extinguished, constitutes a triumph of engineering skill and ingenuity for the engineers in charge of the operations.

In brief, the original plan was as follows: approximately 240 feet from the mouth of the well, to excavate a pit to a depth of 20 feet; to drive an inclined tunnel downward from the bottom of this pit at a predetermined angle to reach the well casing at a point about 50 feet below the surface; to penetrate the various sizes of pipe in the hole with specially designed tools and equipment; to force certain materials through the tapped holes in the casing into the upward flowing column of oil and gas in order to obstruct the flow, and to either "kill the well" or force the major quantity of oil and gas into pipe lines connected to the well casing at the point of penetration.

Many auxiliary and precautionary measures were employed prior to and during the operations. These included the removal of part of the great mass of hot metal near the mouth of the burning well, the construction of huge dikes to confine the oil in case the fire should be extinguished while the well was not under complete control, the building of high metallic and asbestos shields to protect buildings in the vicinity, the dynamiting of nearby steel derricks, the removal of wood derricks and other wood structures, and the stationing of a Bureau of Mines rescue car for emergencies which might arise. Streams of water were played on equipment which could not be removed from the fire area, and the men who were required to work in the intense heat were likewise protected by being sprayed with streams of water.

A few of the operations warrant a more detailed description. When the face of the tunnel was within ten feet of the well, small test holes were drilled to the casing to ascertain if there were leaks which might cause large volumes of gas and oil to enter the tunnel with resulting disaster to

FIG. 1. A DIVERTER IN USE

Placed over the casing of the burning well, this pipe carries away much of the gas escaping at the mouth. The stream of water is to prevent the pipe from being warped by the heat

* Published by permission of the Director, U. S. Bureau of Mines. (Not subject to copyright.)

† Uren, L. C., *Nat. Petrol. News*, Jan. 9, 1929, p. 52.

‡ For further description, see *Oil Bull.*, Oct., 1928, p. 1038; Dec., 1928, p. 1256; and Feb., 1929, p. 133. See also *Calif. Oil World*, Nov. 8, 1928, p. 1; *Oil and Gas Jour.*, Nov. 1, 1928, p. 54; *Nat. Petrol. News*, Jan. 9, 1929, p. 51.

the workmen and to the operations. No leaks were found, and the tunnel was driven to the casing, where it was discovered that a rather large cavity had formed. There were four concentric strings of pipe in the well at the tunnel level; 15-inch, 11-inch, 9-inch casing, and 4-inch drill pipe.

Briefly, the method of penetrating the pipe was as follows: Pipe clamps, with suitable gaskets and packing, were installed on the 15-inch pipe near the top and bottom of the chamber. From each clamp extended a heavy nipple, to which was screwed a gate valve. A stuffing box was then placed on each valve. The pipe was penetrated by a drill which operated through the stuffing box and gate valve connected to the clamp on the 15-inch casing. After penetrating the 15-inch casing, the drill was withdrawn sufficiently to permit closing the valve, after which it could be safely withdrawn from the stuffing box. The annular space between the 11-inch and 15-inch pipe was then cemented. After the cement had set, a section of the 15-inch pipe was removed by air cutters and part of the cement was chipped away, exposing the 11-inch pipe. Similar operations exposed the 9-inch pipe, care first being taken to center the 9-inch in the 11-inch by means of three stud bolts through the clamps on the 11-inch. Clamps were then placed on the 9-inch casing which was penetrated in a manner similar to that employed on the 15-inch and 11-inch casing.

After removing the drill, connections were made to the valve, and aluminum and wooden balls, of dimension sufficient to pass between the 4-inch and the 9-inch, but too large to pass between the tool joint and the 9-inch, were forced into the upward flowing stream for the purpose of forming a bridge between the drill pipe and casing. Asbestos, rope fibre, cottonseed hulls, and mud were then injected. The bridge was formed successfully and the pressure at the connection raised from 15 to 1,000 pounds per square inch. This bridge, however, did not have the desired effect, as the fire showed no signs of diminishing; probably the greater part of the oil and gas flowed through the drill pipe. At this stage of the operations, the drill pipe was penetrated and bridged by means of a 2¾-inch aluminum ball, and then by the various other materials used to obtain the first bridge. The fire slackened momentarily but soon resumed its previous intensity, because, during the placing of the bridge within the drill pipe, the first bridge had been cut away by the flowing stream or had been weakened by the heat. After all efforts to restore it failed, connections to the casing were made in the tunnel, whereby approximately 80 per cent of the oil and gas were diverted through three 3-inch lines. The lines were connected to a trap, which in turn was connected to the suction lines of two gas-compression stations. Thus the unique situation existed, wherein a well which was burning at its mouth was delivering about 4,000 barrels of oil and 9 million cubic feet of gas daily.

This diversion of oil at a point below the well head reduced the fire to such extent that the tangled mass of debris surrounding the mouth of the well could be removed entirely, and the fire was subdued by comparatively safe methods.

The final operations consisted in constructing a steel bell with a 20-foot stack. A 12-inch valve was installed at the top of the stack, a 6-inch valve at the bottom for diverting the oil, and a 12-inch valve at the side. The bell was placed over the burning well by a steam shovel crane. Dirt was packed around the base by means of the steam shovel, hand shovels, and wheelbarrows, and finally the lower valve was opened. Most of the oil was diverted through pipe lines, connected to the side outlet and stored in remote tanks and pumps; the top valve was closed; and the small remaining blaze was extinguished easily by streams of steam, water and foam.

To prevent similar fires in the future, careful analysis should be made of the cause of this fire. It has been stated that circulation of the mud fluid was lost in the well while passing through the partly depleted Meyer zone. One account of the Getty-Nordstrum fire states that the 9-inch casing had been landed and cemented above the Meyer zone. From this statement it is apparent that there was probably 1,000 to 1,200 feet of open hole in the well, and that circulation of the mud fluid was lost because of the escape of part of the fluid into the formations of the Meyer zone. It would appear, therefore, that if the Meyer zone had been cased or at least completely mudded off and a full column of mud fluid maintained while drilling and particularly while the drill pipe was being withdrawn, the well probably would have remained under control. A further means of controlling high-pressure wells depends upon the use of blow-out preventers.* The various types and the use of blow-out preventers are familiar to almost all oil operators. Especially in drilling wells in undeveloped territory, these devices should be used in conjunction with casing and mud fluid.

The credit for extinguishing a fire on the property of the Shaffer Oil and Refining Company, Cromwell Field, Okla.,† is due primarily to C. O. Rison, former drilling engineer of the United States Bureau of Mines and at present Production Superintendent,

(*Continued on page 114*)

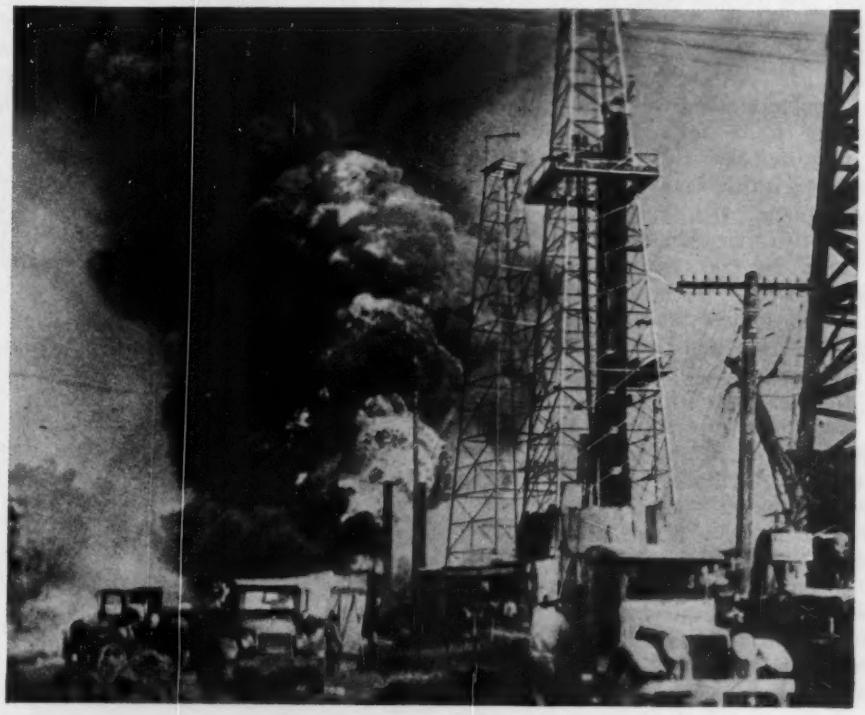


FIG. 2. THE SANTA FE SPRINGS FIRE
Two recent fires in this territory caused a loss of over two million dollars

* See Swigart, T. E., and Beecher, C. E., Manual for Oil and Gas Operations, etc.; Bull. 232, Bureau of Mines, 1923, p. 66; and other bureau publications.

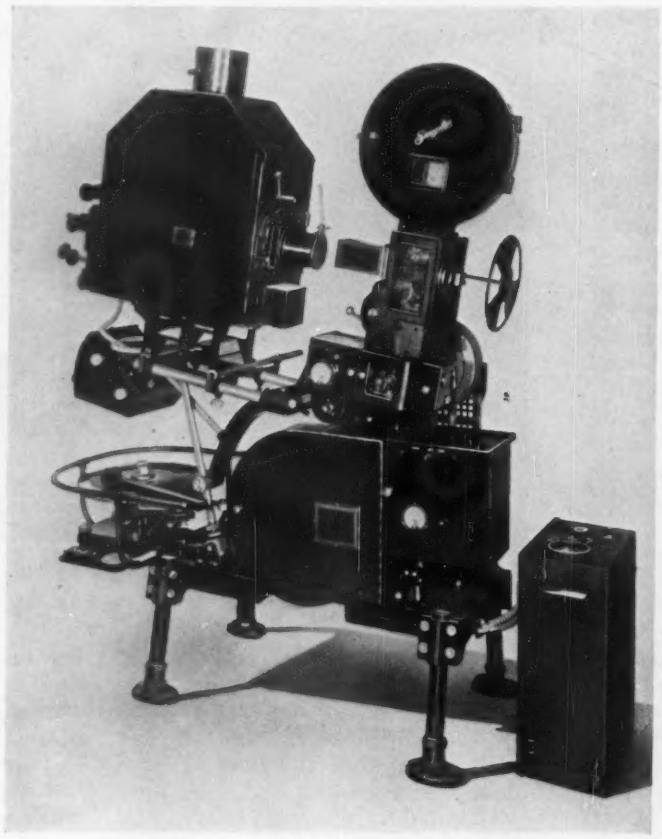
† Rison, C. O., and Bunn, J. R., Petroleum Engineering in the Cromwell Oil Field; Bureau of Mines Field Report, Dec., 1924, pp. 25–29.

Sound Moving Pictures*

The disc and film record systems of sound projection in modern theaters

By EDWARD O. SCRIVEN '10
Bell Telephone Laboratories, Inc.

IN theaters at which motion pictures accompanied by synchronized speech or music are presented, the records come in two forms. Some are composition discs similar to ordinary phonograph records, while others are standard motion-picture film bearing at one side a track of alternate light and dark bands, of varying density. In either case, there must be apparatus synchronized with each projector to derive from the records an electric current in which all the variations in pitch and loudness are accurately represented. There must in addition be apparatus to amplify the current, to effect its conversion into sound and so to direct the sound into the theater auditorium as to create the illusion that it emanates from, rather than merely accompanies, the picture. When a theater is being prepared for presenting sound pictures, the film projectors in use are ordinarily retained but each is fitted with a new motor and driving mechanism; it is provided with a turntable and electric pick-up for disc records, and with analogous equipment for film records, or both. The pick-up used for disc records is in some ways similar to the reproducer of an ordinary acoustic phonograph, with a needle holder connected to a clamped diaphragm of highly tempered spring steel. To the diaphragm there is fastened an armature made of a special high-permeability alloy, so arranged that as the diaphragm and the armature vibrate, the flux in the air-gap of a permanent magnet varies correspondingly; in appropriately placed coils currents are induced which are the electric representation of the wave groove which moves past the needle. Although this instrument delivers energy at a comparatively low level, it has a very uniform response over a wide range of frequencies. That result has been secured largely by preventing distortion which would arise from resonance in any part of the system; the members have been designed with natural periods beyond the range of frequencies to be transmitted, and the magnet chamber back of the diaphragm is filled with a heavy oil to damp free vibration. The films used with the disc records, called synchronized films, differ from ordinary films only in that one frame at the beginning of each is marked to give the starting point.



TYPICAL ASSEMBLY OF APPARATUS

The projecting mechanism is above. On the lower left is shown the mechanism for disc records, while on the lower right is the apparatus for film records.

With the optical or film records, the sounds are represented by parallel bands, alternately light and dark. Intensity or loudness is represented by differences in density of the record, and pitch by the closeness of the bands. For reproduction from these, another apparatus group is required, and it too is connected to the projector. A narrow light beam of high intensity passes through the film record and falls upon a photoelectric cell to produce a current corresponding to that from the original recording transmitter. There is fastened to the projector an "exciting" lamp and a system of lenses for focusing its light upon an aperture 0.0015 inch by 3/16 inch; by other lenses the image of the aperture is then brought to focus upon the film record as a line 0.001 inch by 0.080 inch. Since the track on the film is 0.100 inch wide, there is an allowance of 0.010 inch on each side for variation in its position. The position and focus of the lens tube are fixed, but the exciting lamp is mounted on a movable carriage so that new lamps as installed may be brought properly into focus.

A photoelectric cell is used, which, when polarized by a proper voltage, passes a current proportional, within limiting values, to the intensity of the light falling upon it. The polarizing voltage is supplied to the cell through such a high resistance that in operation there is obtained from the cell a voltage across the resistance proportional to the incident light. The voltage bears, therefore, at any time, an inverse relation to the density of that part of the sound track then between the exciting lamp and the cell.

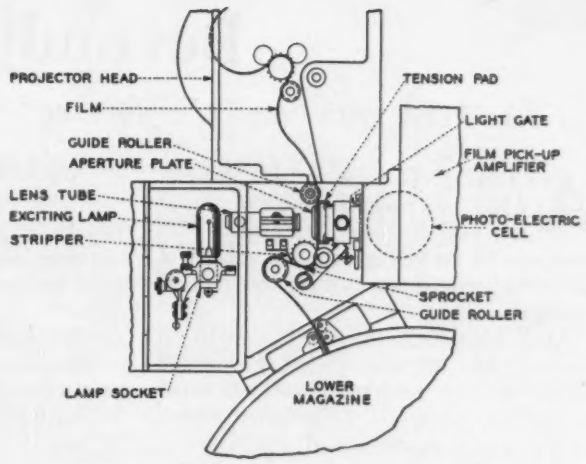
The photoelectric cell circuit is inherently one of high impedance. In such a circuit local interference — "static," to use the radio expression — is readily picked up, and since the energy level is low, the current so acquired may be appreciable in comparison with the sound currents themselves. In addition the shunting effect of the capacity between the conductors is noticeable, particularly at the higher frequencies. Hence a vacuum tube amplifier, which serves both to increase the energy and to make that energy available across a low impedance circuit, is closely associated with the cell upon the projector itself. Cell and amplifier are enclosed in a heavy metal box made fast to the frame of the projector, and the frame is carefully grounded. As a further precaution, the amplifier is supported within the enclosing box by a rather elaborate flexible suspension, lest vibration of the vacuum tubes introduce noise components into the current. The amplifier brings up the energy level to about that obtained from the magnet coils of the reproducer for disc records.

It is evident from the relative location of apparatus, shown in Figure 1, that it is not feasible to print the film with the pictures directly opposite corresponding parts of the sound record. Furthermore the pictures move

*Reprinted with permission from the Bell Laboratories Record.

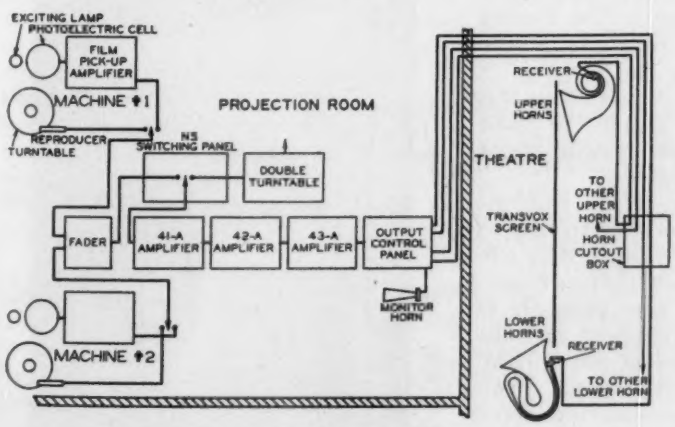
intermittently before the projection lens, while the sound record must, of course, move uniformly in front of the photoelectric cell. Picture and sound record are therefore separated longitudinally by 14½ inches, and a certain amount of slack is allowed between the sprocket carrying the film in front of the projection lens and that carrying it before the photoelectric cell. To prevent vibration of the projector or variations in the supply voltage or load from varying the speed of the latter sprocket, it is connected to the other moving parts of the system by a mechanical filter which absorbs any abrupt changes in speed. The driving motor is held electrically at the correct speed, but at will the automatic control can be disconnected and the speed regulated manually by the operator.

As with ordinary motion-pictures, two projectors must be used alternately to present a continuous program. At the end of a record, the music or speech coming from one machine must be blended imperceptibly into that from the other just as the picture from one reel is faded into that from the next. At the end of each sound film or disc the music overlaps that at the beginning of the next; to make the transition there is a device called a fader, a double potentiometer. As the starting projector goes into operation, the fader knob is turned and the current delivered to the amplifiers is changed quickly until it comes entirely from the new record. Ordinarily the fader is installed with auxiliary dials and handles, so that the operator can control it from any position around the projectors. In its lower range used in changing between projectors, the steps are rather large, whereas in the upper range the volume changes in scarcely perceptible steps. The fader thereby fills another use; it makes possible any volume of sound desired, within reasonable limits, by choice of the proper step in the upper range, and thereby permits equalizing the level of sound obtained from different records. There is provided as well a switch for changing from film to disc records, and the reverse, and a key for connecting a spare projector in place of either of the regular machines.



SECTIONAL DRAWING OF PROJECTOR
The arrangement for reproducing sound films is clearly shown

After passing through the fader, the sound currents go to the main amplifier, where their energy is raised to a level adequate for the loud speakers of the particular theater. This combination of apparatus is capable of multiplying the energy 100,000,000 times, and is so designed that all frequencies in the range from 40 to 10,000 cycles are amplified about equally. A potentiometer is provided on the amplifier but after it has once been adjusted at the time of installation it is ordinarily not changed; necessary adjustments in energy level are made on the fader instead. The amplifier* is built in three units, of which the first consists of three low-power tubes connected in tandem, resistance coupled, with the filaments heated by a twelve-volt battery. In the second unit there are two medium-power tubes with a push-pull connection, whose filaments are heated by low-voltage alternating current. Two similar tubes in this unit act as a full wave rectifier, and supply rectified alternating current for the plate circuits of the amplifier tubes in the first and second units. The third unit has a single stage of high-power push-pull amplifier tubes and push-pull rectifier tubes; like the second, it operates entirely on alternating current. The three units can be arranged to meet any conditions. In small theaters only the first two are required, and in larger houses the high-power unit, the third, is used as well. For unusual conditions two or more of the high-power units may be operated in parallel from the output of the second unit to give a greater volume of sound.



PLAN OF THEATER
The above is a typical layout for the presentation of motion pictures with sound accompaniment

Following the amplifier there is an output control panel consisting of an autotransformer having a large number of taps which are multipled to a number of dial switches. To the switches are connected the loud-speaking receivers, so that the impedance of the amplifier output can be matched to the desired number of horns. Thereby there is secured the most efficient use of the power available, and adjustment of the relative volumes of the individual horns is made possible at any time.

A theater installation ordinarily contains four horns. They are mounted behind a transvocent screen, on which the pictures are shown, so that the sound may seem to come directly from the picture. Two horns are mounted at the fine of the stage and pointed upward toward the balconies and two are mounted at the upper edge of the screen, or above it, and directed downward.

One or more receivers are used with each of the horns. Since these show extremely high efficiency, converting into sound energy thirty per cent of the electrical energy supplied them, they reduce to a minimum the output required from the amplifier. A horn is ordinarily fitted with one receiver, but for outdoor use or other special requirements it may be fitted with two, four or nine by a throat. The maximum electrical input to a horn for continuous safe operation is approximately five watts per receiver. To disperse the soundwaves over a large angle, more horns are needed than for a comparatively small angle. This directive characteristic of the horns is important, since it is responsible for the illusion that the sound comes directly from the mouth of the horn, that is, from the screen. When the horn is replaced by a loud speaker of otherwise identical characteristics which radiates its sound over a very wide angle, the sound seems to come from a point some distance behind the screen, so that the

(*Continued on page 114*)

*H. A. Dahl; BELL LABORATORIES RECORD, May, 1928.

Beyond the Classroom

The rich opportunities for self-development in Institute undergraduate life

By LAWRENCE C. HAMLIN '29

ACCORDING to a noted philosopher the most famous of all of our institutions of learning still happens to be the grand old school of life with experience taking the role of teacher.

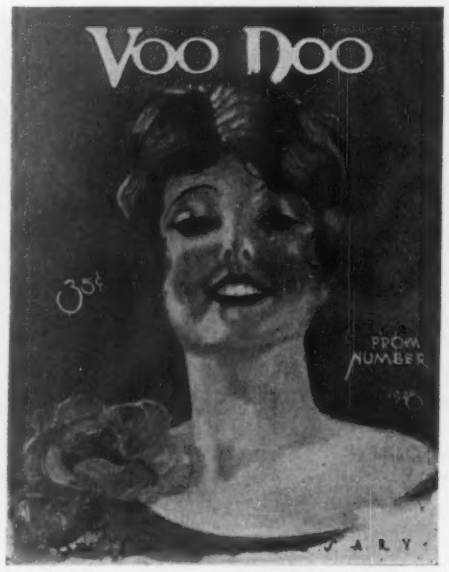
At Technology the development of student life outside of the classroom offers to the undergraduate a most attractive school of experience raised to the same unsurpassed standard as is enjoyed by the purely educational methods of the school of which it is part.

Rather than being deprived of normal life during four of the most formative years of his growth, as is the case with too many undergraduates at our schools of higher education, every student at M. I. T. is offered the richest life available through some phase of the multitudinous undergraduate activities of Technology.

Responsibility is, without a doubt, the gauge which measures the value of experience and it is in this respect that the Technology undergraduate is given the golden opportunity declined to so many of his brother students. In the activities of the Institute the undergraduate learns and enjoys the same responsibility for his actions as will be his by necessity the moment he receives his degree. Failure or success in his ventures pays the same profitable dividends and in neither case is it possible for losses to occur — truly a Utopian condition.

This idea of responsibility has permeated all of the many student activities which M. I. T. offers the incoming student. Probably in no way can this be better demonstrated than in the matter of finances. The expenditure of nearly a million dollars annually is entirely in the hands of the undergraduate managers of the activities, athletic teams, fraternities and other similar student organizations.

The singularity of M. I. T. in this respect may be shown by the fact that Willard J. Slagle '29 in his recent tour of American colleges for the purpose of



raising funds for the 1928 Olympic team discovered that Technology was practically alone in the matter of entire student control over athletic expenditures.

Similarly faculty and alumni supervision of the policies and expenditures of the publications, musical and dramatic organizations, fraternities and other student groups has been conspicuous by its absence.

The growth of Technology's student enterprises to a standard comparable to that of any college in the United States and the meteoric rise in the worlds of engineering and business of those alumni who participated in this growth is a mighty tribute to these activities and to the system under which they have operated.

Athletics at M. I. T. occupy a unique position in the world of sports. Offered in an extremely wide variety with efficient coaches for each they are governed by that most rare principle in collegiate realms, enjoyment and development of the student participant.

Approximately thirty official Institute athletic teams representing fifteen most dissimilar sports invade the sphere of intercollegiate athletic competition during each college year.

Under the nomenclature of official Institute sports may be found crew, track, basket ball, swimming, hockey, boxing, gym, wrestling, fencing, polo, tennis, golf, cross-country, soccer and rifle.

With the mighty god, Championship, occupying a most obscure position in the background, the fact that many championship teams and individualists wearing the Cardinal and the Gray have resulted from this singular governing policy may again be taken as a tribute to Technology uniqueness.

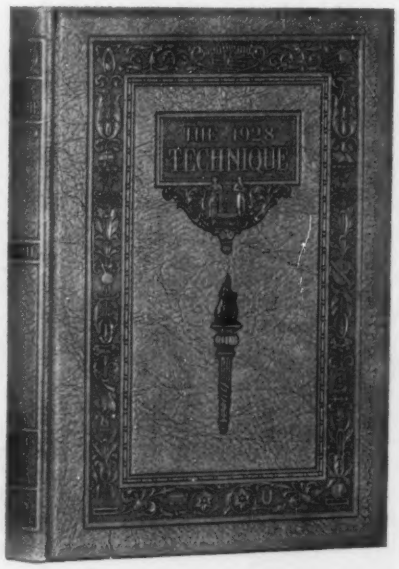
The renown of Technology's athletes and teams is by no means limited to a few sports. The Institute crews have successfully competed with the most prominent schools of the country for many years. Navy, Princeton, Yale, Harvard and the University of Pennsylvania have each rowed in the wake caused by Cardinal tipped oars within the last three years. At the other end of the list, however, is the rifle team which has just won its second New England championship in as many years.

Midway in the list is the gym team which only a few weeks ago tied Navy for first place in the Eastern intercollegiate meet of that sport. In the season just completed the basket ball team finished its schedule with only two losses registered against them.

On the cinder paths, under the tutelage of "Os" Hedlund, former world's champion middle distance runner and perpetual world's champion friend to the fellows of the track house, many luminaries have sprung into the spotlight of fame. "Hank" Steinbrenner '27, one of the best hurdlers of recent

(*Continued on page 112*)

The Tech
M. I. T. Established 1881
CREWS AND TRACK TEAM SET FOR CONTESTS
SPORTS PEP SESSION WILL BE HELD TODAY
DARTMOUTH TRACK AND FIELD FORCES ARE FAVORED TO WIN NEW ENGLAND CHAMPIONSHIP
HARVARD EIGHT IS SLIGHT FAVORITE IN REGATTA ON CHARLES RIVER TOMORROW
BEAVERS AND B. C. HAVE FAST TEAMS
FOUR TECHNOLOGY CREWS WILL RACE
M. I. T. A. A. HOLDS AWARDS BANQUET
NEW COMMITTEE ASSUMES CHARGE



Editorials

OPEN HOUSE

By far the largest of all Technology functions, the Open House program on April 27 will probably receive a record attendance well in excess of the twenty thousand visitors last year. Started a few years ago by the Combined Professional Societies as an undergraduate activity, the magnitude of the project has grown by leaps and bounds, until today students, faculty and members of the administration join in the plans to make the affair a success.

Almost everyone has an idea, of one sort or another, as to the equipment and type of work carried on here at Technology, but few are the people whose mental pictures of the Institute and its workings are at all correct. On Open House Day, the general public is given an opportunity to see the Institute as it really is, with the laboratories open and the students and staff at their work; to roam through the buildings, stopping at various places which happen to catch their interest, learning new things about science and its engineering applications.

The nature of our guests on this day is as varied as their numbers are great. There are parents in search of a school for their sons, persons well acquainted with technical life who are interested in the latest developments, youths acquiring the foundations of their knowledge in science while still in preparatory school, curiosity seekers in search of the spectacular and the new — all are found in the corridors on Open House Day, and each carries away with him a clearer picture of the spirit and method of Technology.

THE TECH ENGINEERING NEWS considers it a privilege to be able to cooperate with the Open House program. In addition to our regular material for this month, we are publishing articles on the relation of the engineering professions to the courses at M. I. T., and on the various features of our undergraduate life. To those who attend the Open House Day, these articles should provide valuable supplementary information; to those who are unable to visit the Institute, they should serve to create a better understanding of M. I. T.

EINSTEIN

Why is it that Einstein is so incomprehensible to the average man? The difficulty is, that Einstein uses the language of mathematics; few men have the command of it that Einstein possesses. Unfortunately there is no language which everyone understands into which his mathematical theories can be translated. The only way an extensive knowledge of them can be gained is to acquire the necessary mathematical knowledge. They must therefore remain unknown to the great majority who have not specialized in mathematics.

It is, therefore, not because of the principles underlying Einstein's theories that they are incomprehensible, for there is nothing difficult to grasp about them. Indeed, physicists are coming to regard them as truisms, and to wonder why it was necessary for Einstein to have to remind them of these things. Probably one of his most important contributions to physics in general is the alteration he is effecting in the way in which the results of experimentation are regarded. He is eradicating the belief in assumptions unproved experimentally. Formerly, if the results of an experiment seemed to indicate that within the range of the experiment certain relations held, they were assumed to hold, for conditions not duplicated in the experiment. For example, the relation "force = mass × acceleration" was arrived at through experiment with masses and velocities met in everyday human experience. When this relation was applied to the study of the atom, it was found that numerous discrepancies existed. Physicists were in a quandary, until Einstein suggested that the relation did not hold for very small masses and very high velocities. He went further to show the precise relations that did exist instead of the generally accepted ones.

In short, unless every assumption that is made has experimental backing, it has no practical use. It may help one to understand natural phenomena, but there is as much chance that it will lead him astray. One prominent scientist naively suggests that this principle be applied to all human affairs. He reflects happily on the time when no one will say anything he cannot definitely prove.

PROFESSOR EDWARD FURBER MILLER

Few members of the faculty are better known, both to the Institute body and to the world at large, than Prof. Edward Furber Miller, the subject of the second of THE TECH ENGINEERING NEWS' series of faculty sketches. The story of Professor Miller's career is one closely allied with the growth of Technology, for he has been connected with M. I. T. for a period extending over forty-three years.

The early part of his education was received in the public schools of Cambridge, and, on completing his preliminary training with them, he entered the Institute as a member of the Class of 1886. Following his graduation he returned to Technology as a member of the staff of the Department of Mechanical Engineering, in which he became an instructor in 1888. Four years later he was promoted to be Assistant Professor of Steam Engineering. In 1899 he became an Associate Professor, and in 1905 he received the title of Professor of Steam Engineering. On the retirement of Prof. Gaetano Lanza, who was made Professor Emeritus, Professor Miller was made Head of the Mechanical Engineering Department. In 1921 he was given the honorary degree of Doctor of Science by the Rhode Island State College.

Professor Miller has always played an important part in the growth of his department. From time to time, when additions in equipment and machinery have been made, he has personally supervised the installation of the new apparatus. When the Institute erected the new buildings and moved from the Boylston Street site, he was in charge of the plans made for all the laboratories and drafting rooms of the Department of Mechanical Engineering.

During the war he had an enviable record. Besides carrying on his regular courses, he had charge of the establishment and direction of eight schools, operating at one time, located in different parts of the country, which gave to over six thousand men the necessary fundamental training to enable them to serve as engineer officers in the Shipping Board fleet. He also carried on a number of confidential experiments for the United States Army along military lines. Following the World War he was commissioned a Colonel in the Ordnance Reserves.

In 1920, following the death of President Maclaurin, he was appointed as one of the faculty members to serve on the Administrative Committee of the Institute to take charge of affairs until a new president was chosen. In 1921 he was elected to the position of Chairman of the Faculty and was appointed by the Corporation as Dean of Army Officers at M. I. T.

Active in many of the professional societies, Professor Miller is a member of the American Society of Mechanical Engineers, the American Society of Civil Engineers and the American Society of Refrigerating Engineers, and has held many important positions on committees of these societies. He is a former president of the Boston Post of the Army Ordnance Association and was the first president of the M. I. T. Chapter of the Reserve Officers' Association.

Not only in the theoretical side of his subject, but also in the practical end, Professor Miller is a master. Since 1897 he has held a first-class unlimited stationary engineer's license in the State of Massachusetts. He is a life member of the Massachusetts Charitable Mechanics Association and an honorary member of the National Association of Stationary Engineers. He has also served in various capacities on boards and commissions appointed by the state for investigation and regulation of engineering matters.

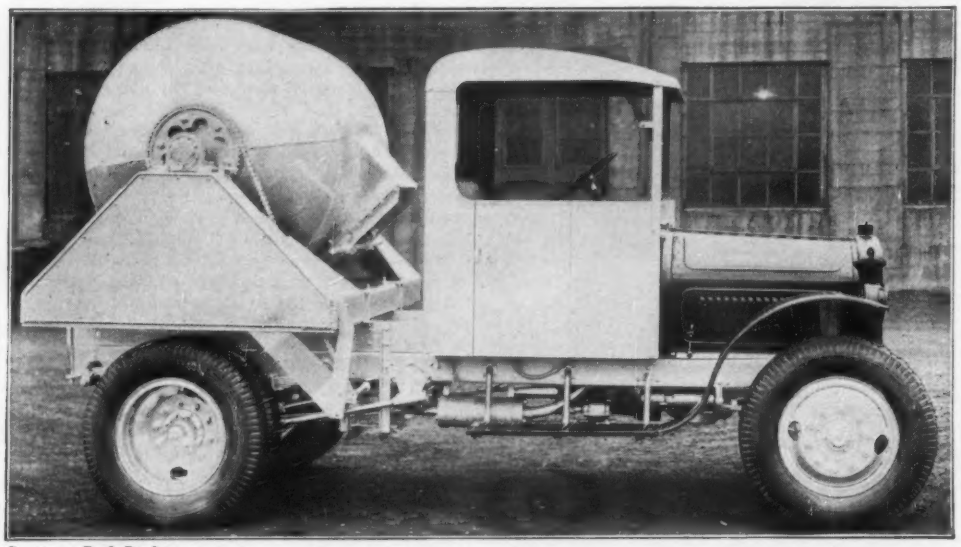
Famous for his rich personality, he has earned the admiration and respect of the student body, as evidenced by his elections to Tau Beta Pi, Theta Tau and Phi Sigma Kappa fraternities.

The Engineering Field

Abstracts from the leading professional and trade journals

Transportation of Pre-Mixed Concrete on a specially developed truck results in actual improvement in the workability of the concrete. The lower water-cement ratio thus attainable insures a maximum strength for the mix.

The body of the truck is a cylinder which is set crossways of the chassis, and is rotated by means of a chain driven by a worm speed-reducing gear. The maximum load of two cubic yards does not fill the body; the space left



Courtesy *Rock Products*

TRUCK FOR CARRYING PRE-MIXED CONCRETE

permits the mix to be agitated, preventing its revolving as a solid mass.

Among several advantages claimed for the truck are: a perfect balance, as the load is always on the center of the chassis; quick charging and discharging, reducing handling costs 50 per cent; the concrete may be spouted seven feet behind the truck on road work.

Wrought Iron is now being manufactured by a so-called "Byers New Process," which promises to be one of the greatest developments in the ferrous industry since the Bessemer converter.

In this process, pig iron, known as Bessemer and having an analysis of 1.5 per cent silicon, 1.0 per cent manganese, 0.05 per cent sulphur, and 0.1 per cent phosphorous, is melted in a cupola. When the metal is liquid, it is tapped into two-ton ladles and treated to reduce the sulphur, and then poured into converters for refining. The next step is to pour the liquid iron into a bath of slag, which results in millions of tiny explosions of the liberated gases, breaking the metal up into tiny pea-sized globules with great speed and great uniformity. When the excess slag is poured off, a spongy ball remains, weighing about 2,200 pounds, and is then passed through the blooming mill and cut to the desired shape.

In comparison with the old process of manufacturing wrought iron, which consisted of melting the pig iron, refining it, and impregnating it with a slag of correct chemical proportions all in one furnace, the Byers New Process can, in twenty minutes, produce as much fine wrought iron as two puddlers working with the old process can produce in a ten-hour day.

A New Water-Cooled Electrode Holder for carbon-arc welding has been designed to insure greater comfort for the operator.

The holder, which weighs only 3¼ pounds, consists of a coiled copper tube through which the water circulates and in which the carbon electrode is inserted. The water hose is used to carry the cables, thus cooling them and making smaller size cable possible.

It is said that this new holder effects a considerable economy in that carbons of smaller size may be used and it is possible to weld with the arc tip only three inches from the carbon holder.

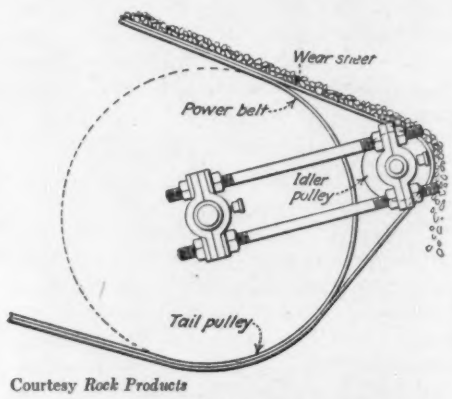
Welding Service Connections to high pressure gas mains is now standard practice with a large gas company. Into the side of an ordinary sleeve coupling is drilled a ¼-inch hole. Over this hole is welded the end of the service pipe, forming, in effect, a T coupling with a length of pipe attached. One end of the coupling is then welded to the main, into which a ¼-inch hole is punched or drilled inside the sleeve. A plug is quickly screwed into the other end, and the connection is finished. The method was adopted because it is cheap and quick, and makes a trouble-proof connection.

A "Kite Cutter" is now being used to clear power lines of kites, papers, and other things blown across them by the wind.

This device consists of a pair of shears mounted on a trolley truck and operated by means of a rope. As the cutter moves along the wire, entangled objects are cut away by the shears. Besides making the lineman's job safer and easier, this device makes it unnecessary to "kill the line" when obstructions are removed.

A Conveyor Belt which is made in two parts is much more economical than the usual single belt. Underneath, against the driving-pulleys and taking all the tension, is a rubberized belt having in it a number of plies of heavy duck. On top is another belt having only one or two plies of duck and having over the top layer a thick covering of rubber to take all the wear and abrasion of the materials carried. This kind of duplex belt saves about 35 per cent of the cost of maintenance.

A "Universal" Blowtorch with two unusual features has recently been put on the market. The one-gallon size has a fuel injection pump which makes re-fueling possible without loss of pressure. This feature enables the workman to heat an object for a long time without the annoyance of having



Courtesy *Rock Products*

DUPLEX CONVEYOR BELT

Courtesy *G. H. Williams Co.*

UNIVERSAL BLOWTORCH

to shut down to refill the pot just as the object has become almost hot enough to work with.

The more unusual feature is found in all sizes. The nozzle of the torch is connected by a swivel so that without tipping the torch at all the flame may be turned directly on the object. This improvement makes quicker heating and hotter temperatures possible and eliminates the risk of fire caused by improvised methods of holding the whole torch in an unstable position.

"Permissible Explosive" of a new type increases lump coal production. In order to be safe in coal mines an explosive must be of the quick burning type, since there may always be present the dreaded "fire-damp," an inflammable gas which, though it will ignite at a fairly low temperature, must have the heat applied to it for an appreciable time before this ignition takes place. Dynamite, or nitro-glycerine in other forms, has always been the only approved explosive because of its high rate of detonation; but its high energy concentration shatters most of the coal and not enough "lump" is left to supply the market.

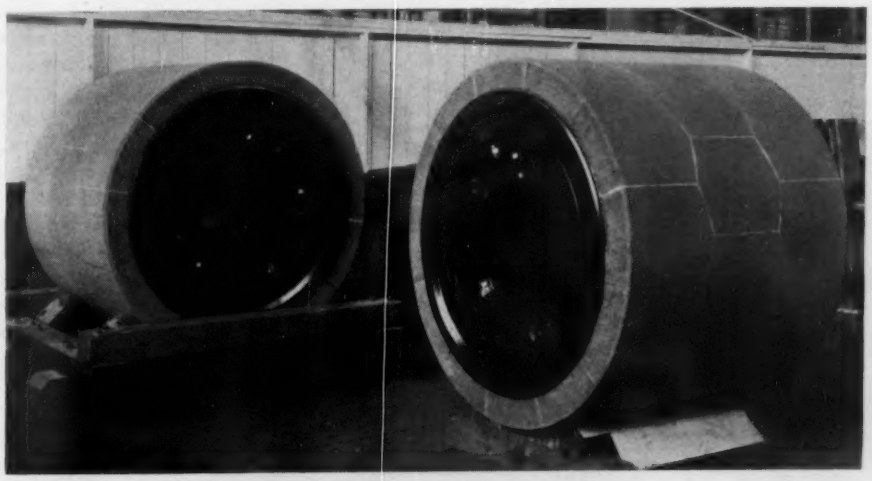
Such expedients as air spacing and inclusion of diotomaceous silica in the dope have been tried but were not very successful. In later years active materials or "dopes" such as sawdust and cornmeal have been used as substances in which to absorb the nitro-glycerine, and the disadvantage in coal mining was made even greater. But in the past three years, manufacturers have attacked the problem by using extremely light dopes such as ground-up balsa, ground oat hulls, and ground pop-corn. Now dynamites can be obtained which are only five-ninths as concentrated as those used some twenty years ago, and the proportion of lump coal has increased accordingly.

A Radio Equipped Airplane has recently been designed by the Bureau of Standards for use in study of the operation of the radio beacon system and other uses of radio under conditions of flight. This airplane is equipped with complete transmitting and receiving set installed in front of the observer's seat, in order that the operators may work the set and, at the same time, be completely informed as to the operation of the airplane without disturbing the pilot.

To insure satisfactory operation of the radio equipment all parts of the airplane were grounded and the engine ignition system completely shielded so that even a very sensitive receiving set might be operated at full sensitivity without interference from the engine ignition. Power for the transmitting set is obtained from a generator driven by the airplane engine.

Segmented Abrasive Wheels are the solution to a problem which confronted manufacturers for years.

Hitherto, makers of artificial grinding wheels have been unable to make satisfactorily wheels of 60 to 70 inches in diameter and 12 to 14 inches in width, the size which is most in demand for shaping tools, small castings, and small forgings. Now these wheels, and others even larger, are made by mounting the wheel in segments on a cast iron center. In the same way, pulpstones of 54 inches to 67 inches in diameter and 27 inches to 54 inches in width have been made and have proved successful. These stones are used for grinding wood into pulp for paper, and are subjected to extremely hard usage, yet the segmented stones are standing up well and are supplanting the natural stones used heretofore.



Courtesy *Grits and Grinds*

SEGMENTED PULPSTONES

A Portable Sump Pump powered by an outboard motor having automatic shut-off and self-priming features is now being manufactured by a well-known concern.

The pump, weighing only 85 pounds, is capable of pumping 195 g.p.m. at an approximate cost of 1 cent per 1,000 gallons. No oiling is necessary because the motor and graphite-bronze bearings are lubricated by the gasoline-oil mixture which is used as fuel.

A New Method of Airport Lighting has been invented by Lieut. J. S. Donaldson. Lights 8 inches in diameter with very high visibility are embedded in the ground and form a large "T" 1,000 feet long. They are synchronized with the weather vane and show direction of existing wind, location of runway, and length of lighted runway. The entire system is turned on at dusk and off at dawn by an electric time clock, or it can be controlled manually in case of emergency.

The use of this automatic control reduces personnel expense at auxiliary landing fields along the established air lines and, at the same time, provides adequate illumination at times when it is needed.

A Metal Shell, which by a new process may be used as a uniform coating of any desired thickness for any substance, has just been perfected in England.

All kinds of materials of any size or shape, both conductors and non-conductors of electricity, can be metallized by this new electro-chemical action. The materials are thus rendered damp-proof and fireproof, with greatly increased strength, and can be rendered non-corrosive and decorative, making them useful in both the exterior and interior building trades. Objects such as wood, plaster, linen, etc., can be rendered immune to the actions of steam, fumes, chemicals, or the elements. It is therefore predicted that great use will soon be made of this metal shell plating process in the manufacturing of household articles. Since great strength and perfect resistance to water corrosion can be obtained, there is no doubt that this electrochemical process will in the future be adapted also to the manufacture of air and seaplane accessories.

Departmental Notes

DEPARTMENT OF ELECTRICAL ENGINEERING

Graduate Research Laboratory

First known as the Research Division, the Graduate Research Laboratory of the Department of Electrical Engineering came into existence about 1912. Some of its early work was of a special nature for outside concerns which supplied the supporting funds, and comprised investigations of such subjects as the relative economic fields of electric, horse, and gasoline trucks; the methods of handling miscellaneous freight at Boston freight terminals; the effect of length of passenger ride upon the net return on the investment in a street railway property; and the factors affecting the delivery service of a large New York department store. At the same time, definite long-time programs of research, like the well-known investigation of "skin effect" in electrical conductors, were entered upon.

About 1915 the American Telephone and Telegraph Company contributed funds for the support of more general research associated with the instruction of advanced students. For a number of years much of the activity was in studies of certain features of electrical communication, but the previously started programs were continued.

When Technology fortunately became the possessor of more adequate endowment funds, money became available from this source for the support of the laboratory, and it started its third phase of development with still more general programs of research.

During the past five years research activity in the department has increased immensely and there have been a number of major enterprises such as the Round Hill Radio Research, the Boston Edison Communication Research, the National Research Council Illumination Research, and the N. E. L. A. Cable Research, carried on quite independently of the Graduate Laboratory.

The laboratory is under the control of a department committee on research, consisting of Professors Jackson, Laws and Bush, but is more immediately under the direction of the latter. Every member of the staff, however, is considered associated with the laboratory in at least an advisory capacity.

Each year there are three or four research assistants given appointments for work in this laboratory. Each is made responsible for at least one major project, which he carries on as directed research; in addition he assists in the supervision of theses related to this major project, or which fall within his individual interest. This brings each assistant in contact with a variety of problems, and broadens his research experience in general. These appointments are valued highly, and the department has always had a high class of applicants from which to make its selections.

All graduate thesis work is centered in this laboratory organization, as also is some of the senior thesis work. The personnel of the laboratory divides its attention between the supervision of this thesis work and projects of a comprehensive nature, such as are described below. Every effort is made to give the advanced students training in the technique of research, to stimulate their curiosity, and to introduce them into an atmosphere of investigational activity. They are provided as far as possible with student offices within the research rooms, and encouraged to make the laboratory their headquarters during their graduate year.

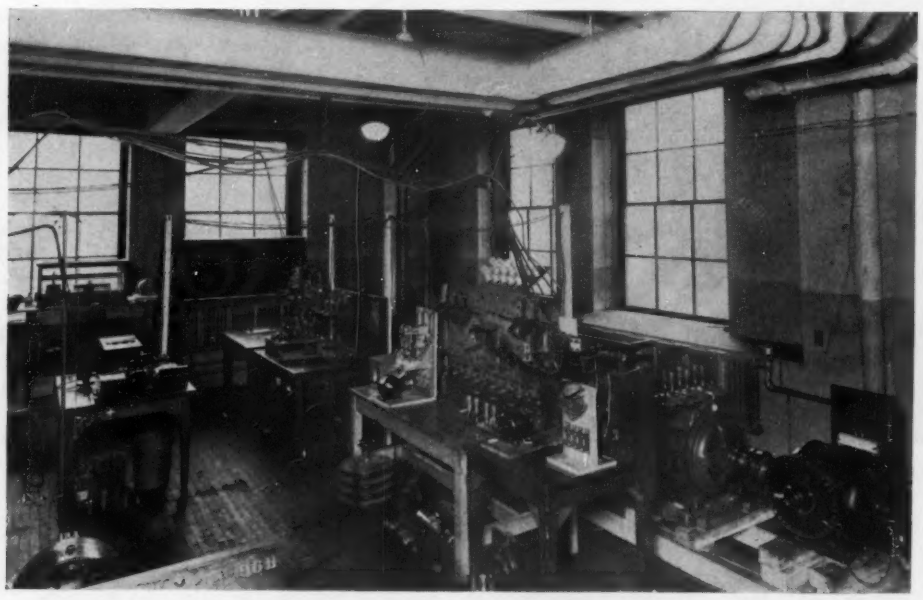
While emphasis is laid upon the training given the students, it is not meant to minimize the importance attached to the research output itself. With the earnestness of purpose which goes with this training, with proper activity along concentrated lines, and the provision of adequate equipment, this aspect cares for itself. Publications and papers before national societies have followed regularly. These are results directly apparent; but indirectly there occurs the stimulating effect of thesis work, personal investigation, the continual injection into the horizon of new and vital problems the discussion of which unconsciously finds its way into the classroom, and the development of exceptional laboratory facilities. A number of cases could be cited in which the research problem or apparatus of yesterday has become subjugated and is one of our laboratory class exercises or exceptional facilities of today.

There are at least four major projects under way in the Graduate Laboratory at the present time. They are the development of the Integraph, the Machinery Transients Laboratory, the Alternating-Current Calculating Table, and the study of that ubiquitous problem of electrical engineering — insulation breakdown. It will be possible to touch upon only three of these, and then but briefly, but anyone interested further is cordially encouraged to visit the laboratory.

The Integraph has been widely heralded as a Robot throughout the press of the world. With the reader's indulgence in continuing this allegory, it may be said there have been two generations of this mechanical family, and a third one is now in the making. The principles of evolution have been in full play — and apparently those of eugenics also — for the lineage has been a rising and glorious one.

The problem of traveling waves on transmission lines had been under investigation in the laboratory for some ten years, but about 1925 progress had come to a pass where it could be immensely accelerated if there were available a machine for performing graphically the continuous integration

(*Continued on page 120*)



MACHINE TRANSIENTS LABORATORY

An unusual feature is the nine-element power oscillograph located on the table at the left

Recent Books

This department conducted in co-operation with the faculty

The Radio Manual. By GEORGE E. STERLING. *D. Van Nostrand Co., Inc., New York City. 666+vii pages. Price $6.00.*

Mr. Sterling's position as radio inspector and examining officer makes him particularly well-fitted to write a book of this type. There is real justification for this latest addition to books on the Radio Act, and it answers a need long felt by commercial and amateur operators. The treatment of the subject is a little unusual for books ostensibly for men without a profound knowledge of alternating current theory, and the material is covered so rapidly that difficulty is likely to be had in thoroughly understanding it. Contrasted with the brief treatment of alternating current theory is the very detailed and clear explanation of the electron theory. Seeming inconsistencies of this type probably arise from the author's attempt to combine a textbook with a manual for the commercial operator.

The most noteworthy material in the book is that on short wave theory and practice. Much of the material has never before been printed in book form and a large part of it has been drawn from *Q. S. T.*, the publication of the American Radio Relay League. The book also contains detailed data on the latest commercial marine installations.

The first seven chapters discuss elementary electricity and magnetism, and the theory of the various units of a radio installation. This section includes the theory of vacuum tubes, wavemeters, piezo-electric oscillators, and wave traps. Chapter five gives the theory of crystal control, self-rectification, continuous waves, and interrupted continuous waves applied to the Hartley, Collpitts and Meissnec circuits. With this as a background, the author devotes five chapters to a discussion of complete transmitters and receivers, including the most commonly used of the marine installations. Chapter thirteen contains much new information on marine and aircraft radio beacon and direction finders. Chapter fourteen gives an account of the development of amateur short wave apparatus. Chapters fifteen and sixteen contain the radio laws and material on handling and abstracting traffic. The book includes three appendices which contain the United States Navy station schedules, data on automatic alarm apparatus, and a kilocycle-meter conversion table.

The book is well worth reading. It treats almost every phase of radio of present-day interest in a straightforward manner which enables much material to be covered in relatively few words. It is of course a manual and cannot cover all the phases of radio in detail. However, the treatment is such that it can easily be supplemented with reference books should the reader desire to make a deeper study of any particular subject.

J. N. FRICKER

Elements of Practical Mechanics. By CHARLES R. MACINNES, PH.D. *D. Van Nostrand Co., Inc., New York City, 1929. 131 pages. Price $2.25.*

In preparing this book on mechanics for engineering students, Professor MacInnes has departed from the traditional method of developing the subject in two respects. He has treated it by illustrative and illuminating examples rather than in the abstract. The elimination of theoretical proofs greatly simplifies and condenses the subject matter, allowing more ground to be covered by the student in a shorter time. Nothing has been omitted, however, that would be of any value to an engineer. This is a welcome innovation and should greatly clarify the subject for beginners. His second innovation is the stress laid upon graphical solutions as well as analytical work, a point in which some of the best books on the subject are lacking.

For one who has confined himself to 131 pages, Professor MacInnes attempts to cover a tremendous field. Coplanor and Non-coplanor Forces, Center of Gravity, Rectilinear and Curvilinear Motion, Work, Energy, Power, Moments of Inertia, both of area and mass, Impact, Momentum, and Motion of Rigid Bodies are his chapter headings. The treatment is necessarily sketchy, but the author covers the fundamental principles in a clear and concise manner.

Considerable class work would be necessary to supplement the text if the proper results are to be obtained, but for students supposed to possess but a slight knowledge of the calculus there is seldom a text found that puts the fundamentals across in such an understandable and human way. The student should instantly grasp the practical side of the problem, and it must be confessed that the abstract side is seldom retained by any but advanced students. In one or two instances the author touches on advanced topics such as the gyroscope which are clearly outside the scope of the book. The author has included an excellent set of problems and answers of a nature to bring out the underlying principles in a clearcut manner.

C. F. E.

Handbook of Refrigerating Engineering. By W. R. WOOLRICH, M.E., *Professor of Mechanical Engineering, University of Tennessee, Member A. S. M. E., A. S. R. E., Honorary member N. A. P. R. E. Published by D. Van Nostrand Company, Inc., New York. 319 pages. Price $4.00.*

There is need today for a good combination textbook and handbook on refrigeration, a book from which the student can learn fundamentals and theory and to which he can turn later for specific construction and operation practice.

Professor Woolrich's book is apparently an attempt to fill this need, but it falls short in three particulars. Of 319 pages less than 200 are devoted to printed matter. In these pages the subject of refrigeration is covered very completely, hence vagueness and repetition are prevalent, overemphasis and underemphasis occur in a number of places, and, due to poor organization of material, terms are used which are explained only in some other portion of the book. These faults are important both to the engineer, who wants, in addition to theory, details which can be found quickly, and to the student, who must have his information well organized with proper emphasis on each part.

The sections on condensers, compressors, and refrigerating systems are well written and contain much valuable information, as do those on refrigerants; but in the latter case the tables included are in too small print to be easily read, and the charts reproduced are so small as to make accuracy impossible. Each section is fittingly closed with a brief summary, a few simple problems, and a few questions. The last section of the book contains a large number of tables, some of which are wholly pertinent and others of which seem to have no excuse for their inclusion in a handbook of refrigerating engineering. Among the latter are: "Melting Point of Firebrick," "Safe Bearing Loads of Soils and Rocks," and "Recommended Distances from Boilers to Grates for Burning Bituminous Coal."

The price of the book seems, on the whole, rather high for the grade of paper and binding, and for the caliber of material.

R. C. M. C.

The American Petroleum Institute

(*Continued from page 89*)

placing methods of production and utilization upon a firmer scientific basis.

Funds for this program have been made available by John D. Rockefeller and the Universal Oil Products Company, each contributing $50,000 a year for five years, beginning July 1, 1926, representing a total of half a million dollars. During the present college year, the Institute is supporting, through use of these funds, thirty research projects, covering problems in chemistry, physics and geology, distributed among seventeen universities and governmental laboratories. Dr. H. S. Davis, of the Massachusetts Institute of Technology, is in charge of one of these projects entitled "A Study of the Relative Rates of Reaction of the Olefins."

The projects pertain to many different phases of the petroleum industry. Some of them deal with the origin of oil and with the fundamentals of oil discovery and recovery. Others have for their object the study of crude petroleum to determine what substances are present, what the physical and chemical properties of these substances are and how they react toward other substances.

Of course, much is already known about these subjects. The industry could not have grown to its present size without the accumulation of a large amount of information; but, relatively, little more than a beginning has been made.

Take, for instance, the refining division. This includes the separation of the crude petroleum into various cuts or fractions and subsequent treatment to make the finished commercial products, such as gasoline, kerosene, lubricating oil, paraffin wax and grease. At present, no one knows just what substances are present in the crude petroleum used as a raw material or in the various products.

Or consider the problem of bringing the crude petroleum to the surface of the ground. Holes are drilled to porous underground "rocks" or "sands," saturated with oil, and the oil is brought to the surface by various means. But this business is carried on under the handicap of incomplete knowledge as to how the oil originated, how it found its way to these underground reservoirs and how it can most effectively and efficiently be brought to the surface.

Additions to the sum of our knowledge of the fundamental facts about petroleum, which may result from the research, cannot fail to be of great assistance in placing present-day methods upon a firmer scientific foundation and in paving the way for future developments.

The Institute has for several years coöperated with the National Automobile Chamber of Commerce, the Society of Automotive Engineers, and the Bureau of Standards in conducting research in the laboratories of the Bureau on problems dealing with the utilization of gasoline and lubricants in automobiles. The results of this work have been published from time to time, and are of value to the petroleum and automotive industries and to the general public as well.

The work of minimizing corrosion throughout the industry is under the direction of the General Committee which consists of the combined membership of the Committee on Production and Pipe Line Corrosion and the Committee on Refinery and Marine Corrosion. These two committees, under the chairmanships of Mr. E. P. Bly and Dr. H. F. Perkins, respectively, are actively engaged in the study of methods and materials applicable to the corrosion problems of the industry. The Committee on Production and Pipe Line Corrosion has prepared the first of a series of good practice codes for the field application of protective coatings to underground pipe lines. This code, No. 1, which deals with the application of hot bituminous coatings, has been approved and published by the American Petroleum Institute. Work on similar codes for other pipe protective coatings is now under way. Research work on the subject of pipe line corrosion and its prevention is being carried on by Dr. Gordon N. Scott, the Institute Research Associate at the National Bureau of Standards. For the present Dr. Scott's activity is confined largely to the study of protective coatings which have been on pipe lines under various soil conditions for long periods of time. Soil conditions are studied in conjunction with the life of unprotected and protected pipe with a view to determining the economic limits which may govern the application of protective measures.

The Committee on Refinery and Marine Corrosion has organized ten topical subcommittees to consider such subjects as condenser corrosion; pressure, pipe and crude still corrosion; tank corrosion; marine corrosion; corrosion resistant coatings, paints, metals, and alloys; and the corrosive properties of crude oils. A subcommittee also will study methods for testing corrosion resistant materials.

A corrosion record of the industry is being compiled. During the past year more than four hundred individual corrosion records were received and summarized as a means of indicating the specific needs for more effective combating the ravages of corrosion in the industry. Each record received is abstracted, and copies are furnished to all coöperating agencies. This widespread dissemination of information prevents duplication of effort in the corrosion prevention work and expedites the adoption and use of improved methods as soon as they are proven effective.

Through the General Committee on Fire Prevention the American Petroleum Institute is engaged in safeguarding the industry against ill-advised and unwarranted fire prevent tion legislation and regulation. The subjects of safe distances between storage tanks, safe loading and discharging of oil tankers, protection of structures against lightning, automobile gasoline filling service stations, tank vents, etc., indicates class of activities undertaken by this committee which is in coöperative contact with such national agencies as the National Fire Protection Association, the National Board of Fire Underwriters, etc.

By virtue of the coöperation of individual companies the committee through the American Petroleum Institute, has been able to compile a very comprehensive record of fires that have occurred in the industry since January 1, 1925.

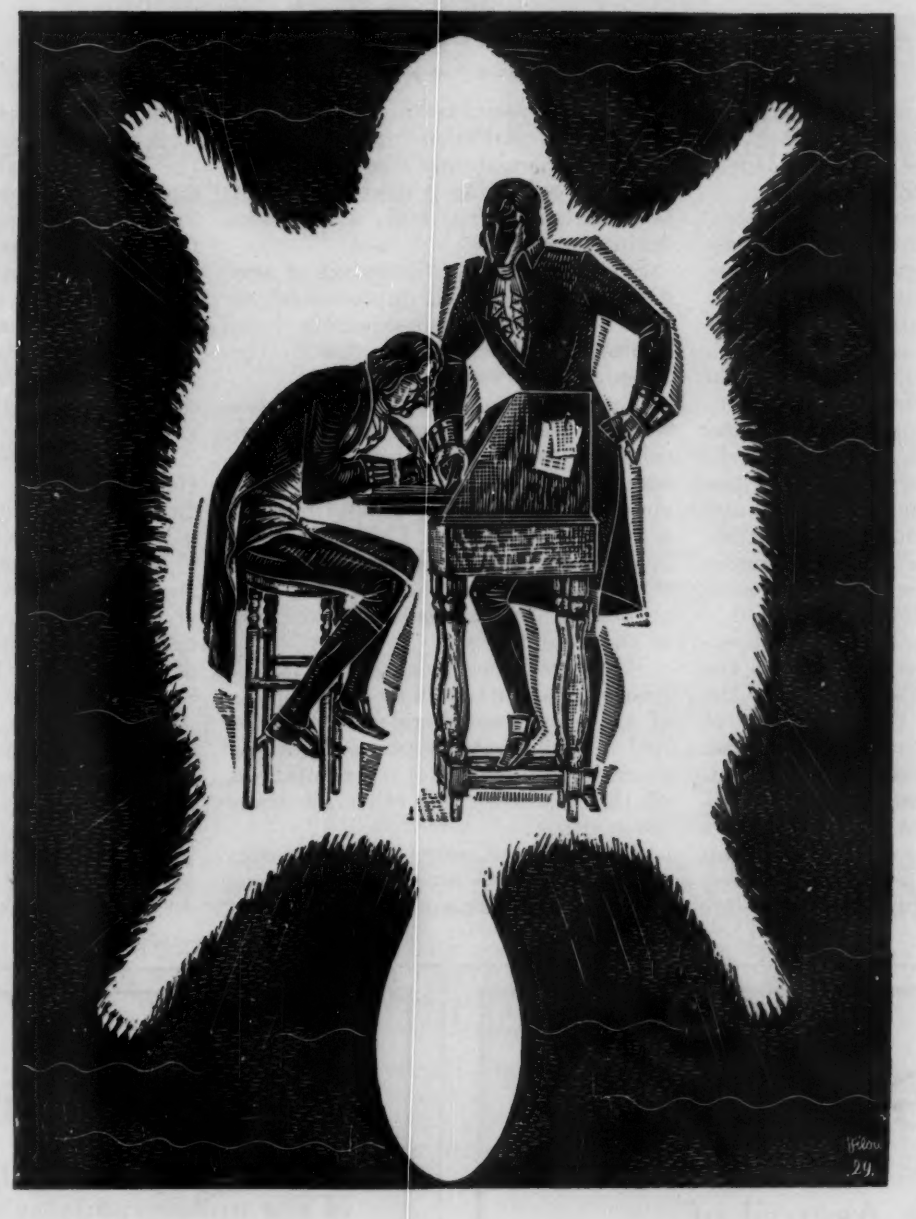
The Institute has coöperated with the National Safety Council and its petroleum section, and, by its support, has participated in the work of issuing Safe Practices Pamphlets on Pulling Wells, Gasoline Service Station Operation, Loading Tank Cars and Handling and Laying Pipe. More than 22,000 copies of these pamphlets have been distributed to various oil companies at their request for the use of their employees.

At the annual meeting of the American Petroleum Institute in December, 1926, the Board of Directors resolved that the president of the Institute appoint committees to investigate oil pollution conditions in the United States and initiate remedial measures and report their findings to the president, the theory being that evils of pollution could be remedied more effectively by coöperation from within the industries than by legislation from without.

In compliance with the above resolution, the president of the Institute appointed committees to carry out this survey which included a total of 619 oil plants and a total of 177 oil fields.

A report covering the survey of oil pollution conditions in the United States with remedial measures recom-

(*Continued on page 106*)



One way to trap a beaver

Not everybody in the Hudson's Bay Company was a trapper, any more than everybody in the Bell System is a telephone engineer.

The Hudson's Bay people trapped a good many beavers in the company offices, where the skilful financing and careful business management served to back up the men actually on the front lines. Organized activity succeeded then just as it does today. The men who put up telephone lines can work the better because back of them are other men who painstakingly design and make their equipment, and still other men who correlate all these activities into a smoothly meshing plan.

BELL SYSTEM

A nation-wide system of inter-connecting telephones

"OUR PIONEERING WORK HAS JUST BEGUN"

The American Petroleum Institute

(*Continued from page 104*)

mended by the committees appointed by the American Petroleum Institute was submitted to the Board of Directors in December, 1927.

Through appropriate committees, the industry's multitude of problems affecting the transportation of petroleum and its products by railroad — except freight rates — are considered. Coöperative relationship with various divisions of the American Railways Association exists, notably the transportation, engineering, and mechanical divisions, which more directly affect the industry's activities in relation to tank car construction and the rules and regulations covering their operation. Likewise all proposed Bureau of Explosive or Interstate Commerce Commission regulations are handled.

During 1927 the Institute coöperated in a joint investigation, with the American Railway Association and the American Railway Car Institute, of tank car dome covers, safety valves, and bottom outlet valves. The investigative work was done, under the direction of a special joint committee, by a representative of the National Bureau of Standards.

A number of these devices were tested at a special testing plant which was erected at Philadelphia, Pa. The results of the test indicated that spring held bottom outlet valves could not be maintained free from small leaks during transit.

Several bottom outlet valves of new design which showed improvement in this respect have subsequently been approved for use on tank cars by the American Railway Association.

The Institute collects and publishes weekly production estimates of receipts of oil at United States ports, current analyses of Government figures, changes in gross crude oil and refinery stocks, summary of California field operations, gasoline consumption by states, etc., giving members full and reliable information as to the condition of the oil industry.

Public relations work in the oil industry is conducted under the auspices of the American Petroleum Institute and directly under supervision of the committee composed of representatives of the Institute and other oil trade associations.

The Institute issues a weekly bulletin to all of its members containing statistics and announcements of various kinds and also periodical bulletins for the Standardization Division and the Division of Development and Production and Production Engineering. Special statistical bulletins are issued from time to time as well as the annual meeting bulletin containing all the papers delivered at that meeting. The report of the Committee of Eleven on American Supply and Demand was published in book form. Under the direction of the Public Relations Division there were published last year "Petroleum Facts and Figures" and the "Handbook for Speakers." The Institute issues in mimeographed form a Daily Oil Digest.

In almost every phase of the petroleum industry, from studying the origin of the oil to developing improvements in service station operation, the work of the American Petroleum Institute is being carried on. Its coöperative activities are gaining for it an increasingly important position, both for the benefit of the industry, and for the country at large.

In a relatively short period of time, it has made for itself a record of service and development which it constantly strives to maintain.

ENGINEERS!

Be Assured of
Lowest Prices
When you

Get Your Tools and Equipment

from

EDGAR F. HUNT & CO.
JAMES H. O'BRIEN, SUCCESSOR
CENTRAL SQUARE
CAMBRIDGE, MASS.

The
Tech Engineering News

Is the PROFESSIONAL JOURNAL of the undergraduates of the Massachusetts Institute of Technology.

It contains articles of general scientific and engineering interest in addition to articles dealing directly with the Institute.

The leading engineering industries of the country are represented in our advertising columns.

Make our acquaintance for one year by filling out this coupon:

.....

THE TECH ENGINEERING NEWS
Massachusetts Institute of Technology
Cambridge A, Massachusetts

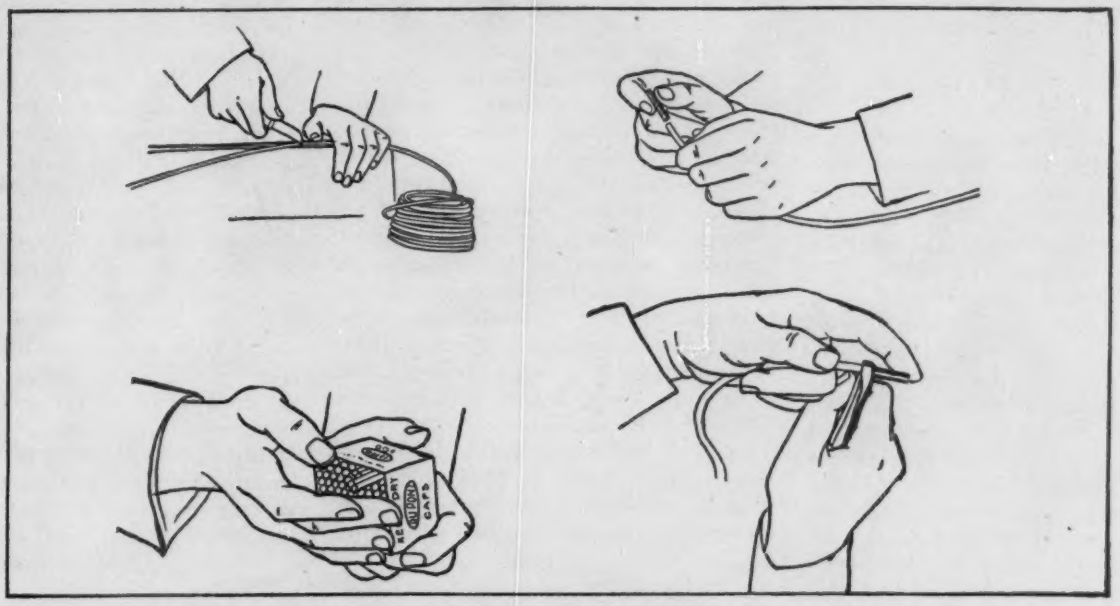
I enclose $1.50 for which kindly send The Tech Engineering News for one year to

_____ (NAME)

_____ (ADDRESS)

_____ (STATE)

Making Primers



Lesson No. 2 of

BLASTERS' HANDBOOK

PRIMING a dynamite cartridge seems like a very simple job when you watch a professional blaster—a thrust into the cartridge, a blasting cap crimped onto the fuse and inserted into the hole, and the fuse tied to the cartridge with a piece of twine.

But each of these apparently simple steps requires experienced handling for the sake of efficiency and safety. Upon proper priming depends ***complete detonation, avoiding the pulling out of detonator, guarding against moisture, easy and safer loading of bore holes.*** There are two methods of detonating a charge—safety fuse and blasting cap or electric blasting caps.

Each step of the several methods of priming a cartridge is fully explained in classroom terms and clearly illustrated in Chapter Two of the ***Blasters' Handbook***.

The entire Handbook, in fact, is one of the practical reference and study works found in the classrooms of leading technical schools, colleges and universities. Written out of the experience of du Pont field service men over a great many years and taken from all fields. Meaty, well arranged, and condensed into handy pocket size.

This coupon will bring you a copy absolutely FREE

DU PONT

REG. U. S. PAT. OFF.

E. I. DU PONT DE NEMOURS & CO., Inc., Explosives Department, Wilmington, Delaware

Without cost or obligation on my part, please send me a copy of the "Blasters' Handbook."

Name .....

Dormitory Room No..... Street.....

City..... State.....

TE-4

Traffic Engineering

(*Continued from page 93*)

cludes signalling of parts of Washington, Tremont and Boylston Streets. All units are to be installed in accordance with the uniform standards recommended by the Department of Commerce.

Future Street Traffic Conditions in Boston

The City of Boston has made, in this, one of the most comprehensive traffic surveys in the country. A report of this survey has furnished the city with adequate recommendations as to what steps should be taken. The city has taken the biggest and most important step by setting up an engineering agency to carry on the important work begun by the survey. This continuing agency insures that the problem of street traffic control will receive its much needed engineering attention. The first big undertaking of this new agency will be the installation of the first unit of traffic signals. An appropriation of $125,000 has been made and the signals will be installed by early summer. The successful installation and operation of these modern traffic regulating devices will furnish the most obvious beneficial result of the application of engineering principles to this problem.

The new code has been installed and there are evidences that the motorist is now more familiar with Boston's traffic regulations than ever before.

Boston has made a successful start and has set up the machinery for continued activity. The only thing that can prevent improvement from being made is a failure, on the part of various city departments, to coöperate. This seems somewhat remote since once the public can witness even the smallest improvement, public opinion will demand coöperation and continued activity.

There is at present a bill before the legislature providing for a centralized traffic agency for the City of Boston, in the form of a Traffic Commission. At the present time the jurisdiction and authority of the various departments are not clearly defined. If the bill passes it will be of great assistance in saving the City of Boston the delays which inure from having to consult so many departments before action can be had.

It should be pointed out that relief from congestion and accidents must be measured in accurate terms — not merely the total number of persons injured or killed, or the mere number of minutes delay to traffic. Both must take into account the volume of traffic, the speed of traffic, as well as the local conditions. The one factor in this plea for relief from congestion, which the public continually neglects to consider, is that traffic volumes are going to continue to increase. It might be shown that for every increase we produce in the efficiency of our traffic control we must expect a corresponding increase in the amount of vehicles trying to use the improved conditions. Thus, for example, there are classes of people who, having cars, do not drive down town because of the congestion, and classes of people, who, having an income sufficient to own cars, will not buy one because of the congestion. Now, as soon as this congestion is relieved to any appreciable extent, these people who never used to drive down town will now commence to do so, and those who have not owned cars because of the congestion will buy cars. The result will be that the downtown streets will receive a heavier burden in this additional volume of traffic. Obviously the system will not work as fluidly and the cry will go up that the system is breaking down, and frenzied efforts will be made to improve conditions. Thus we can never hope to eliminate congestion entirely, but rather should strive to make our streets efficient in the control of traffic and thus permit the greatest convenience to the largest number. Until the public can become educated to these facts, improvements in traffic conditions will continue to be misunderstood and there will be many who will be disappointed.

The Massachusetts Activity

The motoring public has expanded its area of influence. It is common practice today to drive through different cities and even states. Prior to this practice the local regulation of traffic in each individual city or town proved satisfactory, since travel usually occurred within a single city or country, and it was comparatively simple for the motorist to acquaint himself with the rules and regulations prevailing in his immediate vicinity. Now, however, experience has shown that there is a sufficient difference in traffic signs, signals and regulations to bewilder the motorist. It becomes necessary that the best practices be collected and made uniform. With this in mind the Legislature of Massachusetts passed an act providing for uniform traffic signs, lights, marks, signal systems and regulations. This law, Chapter 357, Acts of 1928, creates great opportunities for Massachusetts to establish a constructive leadership in coördinating the control of traffic activities of the entire Commonwealth, and achieving a logical uniformity based upon sound engineering principles.

Purposes of the Act

There are three main purposes of the act.

First: The establishment of a *basic* uniformity in signs, signals and traffic control devices used by the Commonwealth and by cities and towns.

Second: The maximum safety and facility of through traffic movements upon state highway routes lying within the limits of cities and towns.

(*a*) By preventing unnecessary obstruction of such routes due to improperly placed and operated control devices.

(*b*) By protecting such through routes from dangerous interference by cross traffic, to be accomplished through the application, where necessary, of the "boulevard stop" rule.

Third: The creation of a responsible traffic engineering agency in the department of Public Works, capable of coöperating with local officials in developing safe and uniform methods of traffic control.

In order to accomplish the purpose set forth above, the Department of Public Works has secured the services of the Albert Russel Erskine Bureau for Traffic Research in Harvard University, to make a survey and establish such agency as is necessary to carry out the provisions of this act.

The primary functions of the present organization deal with the erection of suitable basic standards for signs, signals and markings to control traffic, together with the designation of state routes within cities and towns as "boulevard stop" arteries. It is expected that there will be prepared a "Commonwealth Sign and Signal Code," to give clear indication to local officials of the requirements of the department and will make possible more intelligent local control plannings. In principle, the code should establish *basic* uniformity, but should be *liberal* so far as *non-essential* details are concerned.

In order that the proposed code may be adopted with a maximum of cooperation from local officials, and a minimum of disturbance to local conditions, the following factors must be considered.

First: The present system of signs and markings used upon the state highways.

Second: Existing signs, signals and markings in use by cities and towns on their highways.

Third: Proposed national standards resulting from current studies of the American Engineering Council and the United States Department of Commerce.

It is believed that the greatest good

(*Continued on page 110*)

1/10th the Breadth of a Cat's Whisker
Between "Go" and "No Go"

THE painstaking spirit of the medieval monk has been handed down to the New Departure organization—and intensified in transmission.

Modern science has augmented the will to intensive effort with the ability to control the unseen and to detect the slightest deviation from exact physical truth.

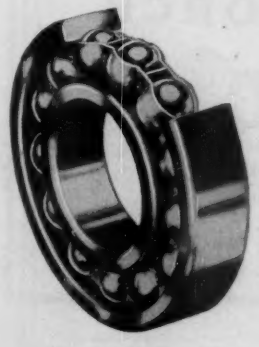
Since much of the superiority of the New Departure Ball Bearings over other anti-friction devices is due to its precision of dimension, contour, and fit, a most elaborate and efficient inspection system has been developed.

Not only is every tenth man in the plant an inspector, but an average of 16,200,000 separate and distinct decisions are made each business day as to the acceptance or rejection of bearing parts. A single bearing, for instance, must be within proper limits on 90 separate counts to avoid rejection, with a tenth of a thousandth of an inch as a common unit of measurment.

In spite of these extraordinarily difficult standards set by New Departure engineers, New Departure special machinery—almost human in its operation; with *more* than human dependability . . . production proceeds with very little waste of time or material.

Is it any wonder therefore that New Departure Ball Bearings have the name of being the precision product of the world.

The New Departure Manufacturing Company, Bristol, Connecticut; Detroit, Chicago, San Francisco and London.



NEW DEPARTURE
BALL BEARINGS

Traffic Engineering

(*Continued from page 108*)

will result if the proposed code for signs and signals be drafted with the full coöperation of local officials charged with this function in their respective communities. The Commissioner of Public Works has communicated with the said officials indicating the purpose of the department and requesting them to hold themselves available to assist through affording information regarding their current practice, and to confer with a representative of the department in the preparation of the code. When the code has been completed it may be desirable to call a state conference or regional conference to obtain the fullest approval and coöperation of local officials in adopting its provisions.

The designation of state routes within cities and towns as "boulevard stop" arteries requires a careful study of local routing problems and the sympathetic coöperation of local officials. The State Traffic Engineering Department is undertaking to gather full information as to the need for protection of the major trunk highways outside of the business districts of cities and towns and of the proper routing of such highways through such communities. The coöperation and assistance of local officials is to be solicited for the prevention of possible local irritation and to obtain effective local coöperation in enforcement.

One of the purposes of the act is to provide a responsible engineering agency capable of giving constructive leadership in sound methods of traffic control and administration. To realize its full value, this agency must go beyond mere passive approval of requests and take the initiative in encouraging backward communities in making proper standard installation of signs and signals.

The character and functions of the traffic engineering division of the Commonwealth should make it a valuable adjunct to the official divisions of the Commonwealth, charged with maintaining safety and convenience upon public ways.

Beneficial results are to be anticipated when all local regulations respecting traffic within the Commonwealth have a substantial uniformity. With the immediate requirements of the Legislature accomplished, the Department of Public Works, through its traffic engineering division, may properly undertake the preparation of a uniform traffic ordinance suitable for adoption and application in all cities and towns of the state. The interest which has been manifested and the many requests which have been received indicate that this constructive move will meet with the enthusiastic approval and voluntary adoption by the communities.

Every effort is being made to expedite this work in order that the cities and towns contemplating the installation of traffic lights, signs and signals may not be unnecessarily delayed.

Activities to Date

The department began its activities by sending to each city and town a copy of the new law, together with an interpretation of its purposes and requirements. This was followed up immediately by a questionnaire covering signs, signals, through streets and local traffic regulations. The returns from this have served to present an accurate picture of the present situation throughout the Commonwealth.

Due to the unusual interest in the through-way regulation the department felt it wise to issue the State Code in sections, releasing each section as prepared. Bulletin Number 1 entitled "Recommendations and Requirements Relating to Through Ways" has been issued and covers the entire subject of through ways. Bulletin Number 2, covering traffic control signals, will be released within a period of a month. Bulletin Number 3 will then be issued and will cover the subject of all traffic signs. The State Code will thus be made up of this series of bulletins. A copy of each will be sent to every city and town immediately upon its release.

An accident study and analysis is also being conducted with special emphasis upon highway construction and conditions as they relate to the causes of accidents. This represents an attempt to develop the existing accident figures in such a way as to give the Department of Public Works an index as to what is the effect of different types of pavements upon accidents, and what is the effect of different grades or curves upon accidents. In addition there are many projects, such as highway lighting, which are being considered at present, the results of which can also be measured in terms of accidents. The relation of all the traffic regulating devices may also be measured.

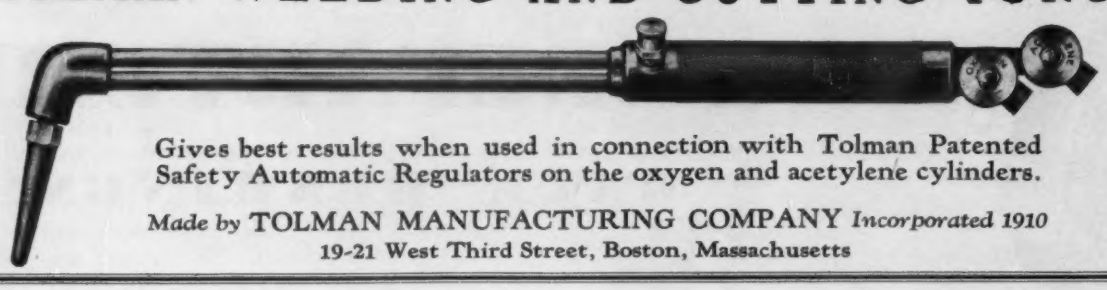
Future Activities

With the completion of the State Code and the proposed uniform municipal traffic code, the department expects to conduct a state-wide traffic survey this summer upon its trunk highways. The volume, speed and obstruction, and origin and destination characteristics will be carefully determined for these highways. This date will present conditions covering the backbone of the entire state, and will represent a base in terms of which all things relating to street traffic may be measured. If this material is kept up to date by current studies, Massachusetts will be in the best possible condition to take care of its highways.

The Trend of Street Traffic Engineering

Engineering is slowly but surely working its way into the field of street traffic. Its beneficial results have been sufficiently obvious to induce practically all of the more important cities to make surveys and establish continuing agencies. With the growth of the traffic problem from the local stage to the stage of wider jurisdictions, traffic engineering has also expanded and we find in the present activity of the Commonwealth of Massachusetts one of the first examples of its wider application. Street traffic presents an engineering problem and must be met wherever it is found by the application of engineering principles.

TOLMAN WELDING AND CUTTING TORCH



Gives best results when used in connection with Tolman Patented Safety Automatic Regulators on the oxygen and acetylene cylinders.

Made by TOLMAN MANUFACTURING COMPANY *Incorporated 1910*
19-21 West Third Street, Boston, Massachusetts

OKONITE

SINCE 1878

The
STANDARD BY WHICH
QUALITY IS JUDGED
in all forms of
RUBBER INSULATED WIRE AND CABLE
VARNISHED CAMBRIC WIRE AND CABLE
IMPREGNATED PAPER CABLE
AND TAPES
Manufactured by

THE
Okonite Company
The Okonite-Callender Cable Co., Inc.
501 FIFTH AVENUE, NEW YORK, - N.Y.

DUDLO

World's Largest Manufacturers of Fine

MAGNET WIRE
and WINDINGS

For Every
Electrical Purpose

Ask for a copy of the DUDLO folder "Wire and Winding Data." It will help you in your work

DUDLO MANUFACTURING COMPANY
FORT WAYNE, INDIANA
Division of The General Cable Corp.

BAILEY METERS

Used by Leaders in Every Industry

BAILEY METERS, already so firmly established in the Central Station Field that they are standard equipment in more than 90% of the up-to-date plants, are now being used more and more by the leaders in every line of industry—where they are reducing the losses, improving combustion conditions and providing accurate, reliable and trustworthy data for accounting systems.

BAILEY PRODUCTS

Automatic Control	Liquid Level Gages
Boiler Meters	Manometers
Coal Meters	Multi-Pointer Gages
Draft Gages	Pressure Recorders
Fluid Meters	Tachometers
Gas Flow Meters	Temperature Recorders
Gravity Recorders	V-Notch Weir Meters

Write for Bulletin No. 81B

Bailey Meter Co.
Cleveland, Ohio

Bailey Meters in a Large Oil Refinery

Beyond the Classroom

(*Continued from page 98*)

years and collegiate champion in 1927, and George Leness '26, champion middle distance man, are two who have won nationwide renown in recent years.

The track team as a whole annually proves its high quality by being one of the chief contenders for the New England crown. As a sport, track draws more than a hundred students within its folds during the outdoor and indoor seasons.

Outside of official Institute sportdom also lies the opportunity for the undergraduate to engage in many forms of athletic pursuit. Squash, tennis and intra-mural crew, football, track, basket ball, bowling and baseball all assist in providing every student with some form of enjoyable physical development.

To those who do not feel themselves adapted to actual participation in athletics and yet whose main interests are along this line there remains the broad field of athletic management. Under the liberal policies of the Institute this means actual charge over the activities of the team with which the student is associated.

Such matters as the hiring of a coach, schedule of games and all financial expenditures rest entirely upon the shoulders of the undergraduates in charge. The alumni have in connection with athletics, as with publications, established an advisory council which renders advice when requested but takes no active participation in the management of the respective teams.

Apart from athletics another rich field for the student seeker of experience is that of publications. Nearly three hundred undergraduates are engaged annually in some phase of the work of the four major publications and the many minor ones.

The principal undergraduate publications are *Technique*, Institute yearbook; THE TECH ENGINEERING NEWS, scientific monthly; *Voo Doo*, comic monthly; and *The Tech*, tri-weekly newspaper. Of these, *Technique* and *The Tech* enjoy the prestige of nearly half a century of continuous growth.

Here again, what and how these publications shall carry their messages to readers is entirely a problem of the undergraduates. Success in no small measure has crowned the efforts of those searching for enjoyment and experience in this manner. Each of these ventures into the literary field has met with financial stability and a high standing among college publications.

The financial turnover of each of the four major publications averages more than ten thousand dollars annually and results in a comfortable margin of profit which may be used for social expenditures on the staff. This together with a widespread recognition of the worth of publication work at the Institute has resulted in fixing upon the individual participant, by faculty and undergraduate body alike, much desirable prestige.

A far step away from these student avocations may be found the dramatic and musical organizations of the undergraduates. Deeply entrenched in Technology's history is Tech Show, which for more than thirty years has conveyed to the outside world the lighter side of the life of the engineering student.

During its brilliant history of musical comedy and revue production, Tech Show has become one of the best known of college dramatic groups and has appeared in nearly every major city in the East and Middle West. Recently it has been decided to make the show localized in nature and as a consequence limit its engagements to Boston and its environs.

One of the most popular of student activities in number of students participating is the Combined Musical Clubs. Consisting of glee, banjo and instrumental clubs plus a dance orchestra and several specialty acts this organization presents to many audiences annually the musical phase of Institute life.

A newcomer in this field of artistic enterprise is the Dramashop which limits itself to the production of stage plays. Among its recent productions is that of O'Neill's "The Hairy Ape." In this group, the few Institute co-eds are able to find a place in the scheme of undergraduate affairs.

All of these dramatic and musical organizations are controlled by the undergraduates. Arrangements for performances and trips, financing, costuming and even, in the case of Tech Show, play and music writing, is entirely cared for by the student managers.

Another entirely different phase of undergraduate life is represented by the Technology Christian Association. Here the undergraduates have moulded an organization whose main purpose is to render service to the student body which it represents with especial emphasis on the new man at the Institute.

One of the prominent features of this organization is its sponsorship of the popular freshman camp. This is held annually at Lake Massapoag, twenty miles outside of the city of Boston, just previous to the opening of school in the fall and here the incoming freshmen are introduced to the various phases and problems of Institute life previous to their matriculation.

In all these activities, an effort has been made to approximate their internal organization to that found in the outside world. Duties are divided according to the abilities of members of the activity. Promotion within the activity is on a competitive basis and elections are made by those in charge of the activity.

Nearer to the classroom may be found the professional organizations. Under the general head of Combined Professional Societies are the undergraduate Civil, Mechanical, Aeronautical and Mining Engineering societies together with the Naval Architecture Society and Corporation XV, an organization of those interested in business administration.

The Annual Open House at Technology is one of the major ventures of this combined group. Coöperating with a faculty committee the Combined Professional Societies assist in making the preparations for the reception and entertainment of many thousand guests during some afternoon and evening in the spring of each year.

In themselves, the professional societies foster the furtherance of professional interest on the part of the student in the course of his adoption. This is done by entertaining speakers from the practicing world and in affording an opportunity to the student for discussion relative to the vocation he will soon undertake.

Over all of these student activities is the governing body of the undergraduates, the Institute Committee. Its personnel is composed of the heads of the various major student organizations and classes plus several elective members.

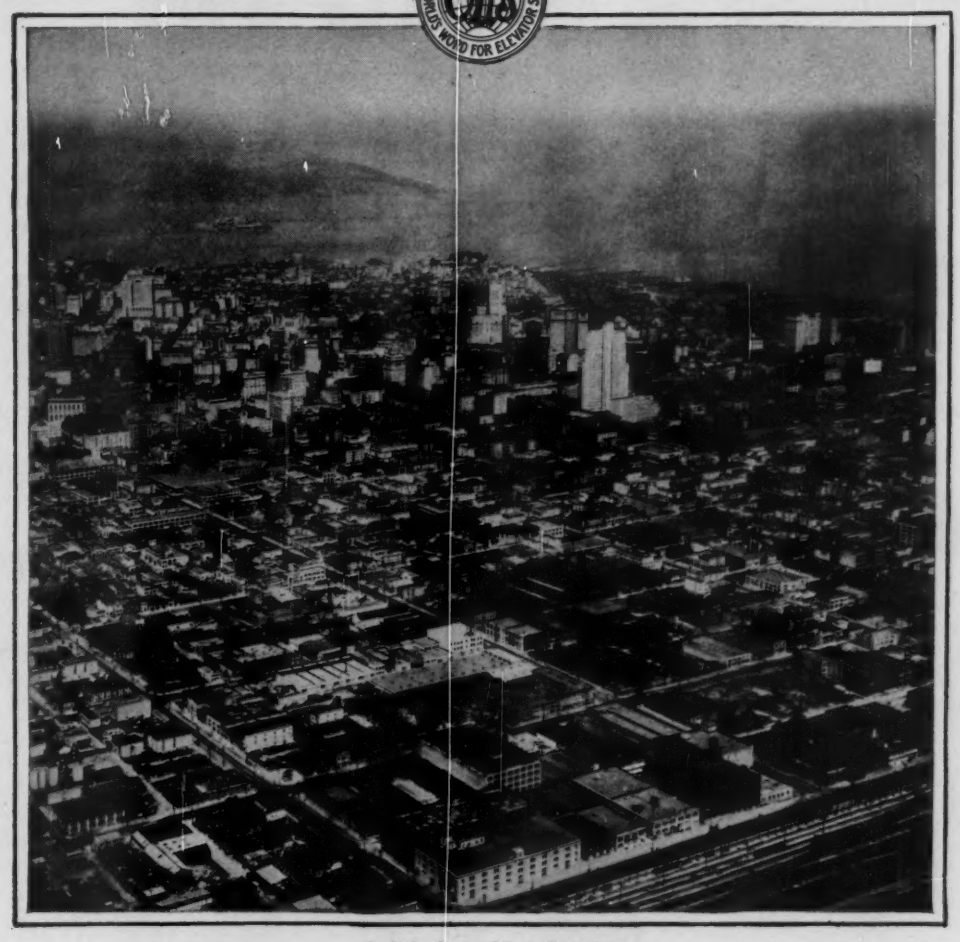
General problems of organization and policy of any of the activities which affect the student body as a whole are dealt with by this body which renders the final decision. It occupies the central position in this broad panorama of undergraduate life and has built up for itself considerable renown for the efficient consideration and disposal of the problems it has encountered.

The life of the student away from the classroom and his campus activities has also been developed to the point where it is highly attractive and of an educative value to the undergraduate.

Twenty-eight fraternities, the majority of which are prominent national organizations, and ten dormitory groups afford the undergraduate a fruitful opportunity to develop the social qualities and to form the friendships which should accompany any educative process.

Numerous dances and other social functions by fraternity and dormitory

(*Continued on page 114*)



Aerial view of San Francisco

A Novelty in '71—A Necessity Today

ACCORDING to old records the first passenger elevator in San Francisco was installed in a photographer's gallery on Montgomery Street in 1871.

Time has wrought great changes since then, and the San Francisco of today is a great city with many tall buildings in which Vertical Transportation is a necessity instead of a novelty.

From coast to coast, American cities are constantly growing; populations increase each year, and buildings mount higher and higher. The Otis organization, which pioneered the way with the world's first **safe** elevator, is today meeting the needs of the present and planning to anticipate the requirements of the future.

OTIS ELEVATOR COMPANY
OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD

Beyond the Classroom

(*Continued from page 112*)

groups, class dances, the Junior Prom and Senior Week are regular social features of the college year. The All-Tech Smoker in the fall and the Tech Carnival in the spring are held annually to afford an opportunity for a social gathering of the entire undergraduate body.

To the Technology undergraduate is thus offered a natural life teeming with enjoyment and rich experience. He is urged to participate in this life by the faculty of his alma mater and the work of the classroom is so adjusted that he may do so with no harmful effects upon scholarship.

When those who reside beyond the shadows of the mighty Institute dome are fully initiated into the exceedingly human ways of Technology undergraduate life the austere views now held by so many will completely disappear. Then the doubly educative process afforded by M. I. T. will be appreciated and respected to the same high degree that the professional aspect now enjoys.

Sound Moving Pictures

(*Continued from page 97*)

illusion of coming from the picture is destroyed.

In addition to its function as a part of the talking motion-picture equipment the sound projector system may also be used as a public address system for voice reënforcement. Microphones may be concealed in the footlights, and the horns so placed as not to affect them; for announcements ordinarily there will be a transmitter in the manager's office.

By means of auxiliary equipment provided, the system can also be used to provide non-synchronized music as an accompaniment to pictures. There is a cabinet containing two turntables, each with a pick-up and means for locating it accurately upon a record, and a fader to make possible continuous playing. The same amplifier and loud speakers are used as for the synchronized speech and music.

Oil and Gas Well Fires

(*Continued from page 95*)

Indian Territory Illuminating Company, Bartlesville, Okla. Quoting from Rison's report, "Well No. 1 on this lease, while being drilled for oil in the Cromwell sand, encountered gas between the depths of 2,718 and 2,738 feet and was shut in on March 10, 1924, with the 8¼-inch casing set at 2,205 feet. The initial volume was 62 million cubic feet daily with a rock pressure of 920 pounds. On April 23, 1924, the open hole below the 8¼-inch casing began caving, and after the 4-inch gas line leading from the "Christmas tree" had sanded up, the well bridged immediately underneath the 8¼-inch master gate.

"Following an unsuccessful attempt to open the master gate in the usual manner, the wheel was taken off and the gate opened by placing a 36-inch wrench on the stem. The well immediately blew the bridge out, the force of the gas lifting the crown block from the top of the derrick. After the well had been allowed to blow for 45 minutes, a friction spark, caused by a rock blown against a steel girt of the derrick, ignited the gas coming from a short joint of 8¼-inch casing screwed into the top of the master gate, as well as the gas coming from a split in the 4-inch lead line which had been crushed when the crown block fell upon it. . . .

"The white hot mass of tangled steel girts, heavy pieces of equipment, as well as a large amount of 8¼-inch and 10-inch casing, which was lying alongside, were dragged from the well with the aid of several hundred feet of cable and a number of teams. After the blocking under the casing clamps in the cellar had burned, the 8¼-inch casing settled down in the hole considerably. An inspection showed that the 8¼-inch nipple below the master gate was loose in the 8¼-inch casing collar resting on the clamps, and that the casing collar itself appeared damaged. Although it was possible to extinguish the burning gas coming from the split 4-inch lead line by turning steam into the discharge end of this line, it was immediately reignited by gas burning from the burned-out gate valve and the short joint of 8¼-inch casing screwed in the top of it. However, with the aid of a heavy spray of water the gas from the 4-inch lead line was kept extinguished long enough to complete the work of securing a cable around the short joint of 8¼-inch casing above the master gate, after which the entire Christmas tree assembly was pulled from the well.

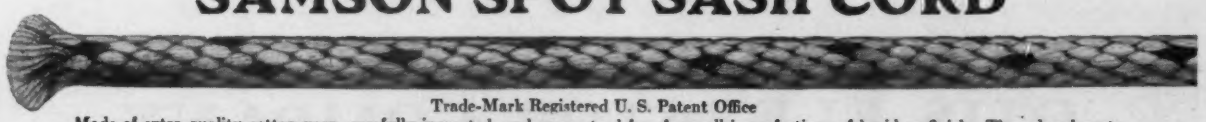
"Inasmuch as the physical condition of the well was such that shooting the fire out with nitroglycerine was inadvisable, and that a sufficient number of steam boilers could not be obtained on account of the impassable roads, it became necessary to divert a sufficient amount of the unburned gas from the well so that the seven boilers then in service could be used successfully."

The report further describes the fabrication of two diverters which were improvised in the field and built with the aid of welding torches. The first or primary diverter was in effect a large pipe bend (90° angle). One branch was built up internally with welding metal to a size which would fit snugly over the 8¼-inch casing, and the other branch was welded to 110 feet of 8¼-inch line. The short end of the diverter was then snubbed to within 3 feet of the well, raised to the required height, pulled into place, and then lowered into position over the 8¼-inch casing. This work was accomplished by means of an improvised crane, the supports of which consisted of tripods fabricated from 4-inch pipe, and by a line attached to the diverter and running through a snatch block chained to the casing below the casing clamps. This diverter handled 39 million cubic feet of gas daily, but the gas which leaked between the diverter and the well casing was of sufficient volume to forestall the efforts to smother it by means of steam from the seven available steam boilers.

Figure 1 shows the primary diverter in place. Approximately 23 million

(*Continued on page 116*)

SAMSON SPOT SASH CORD

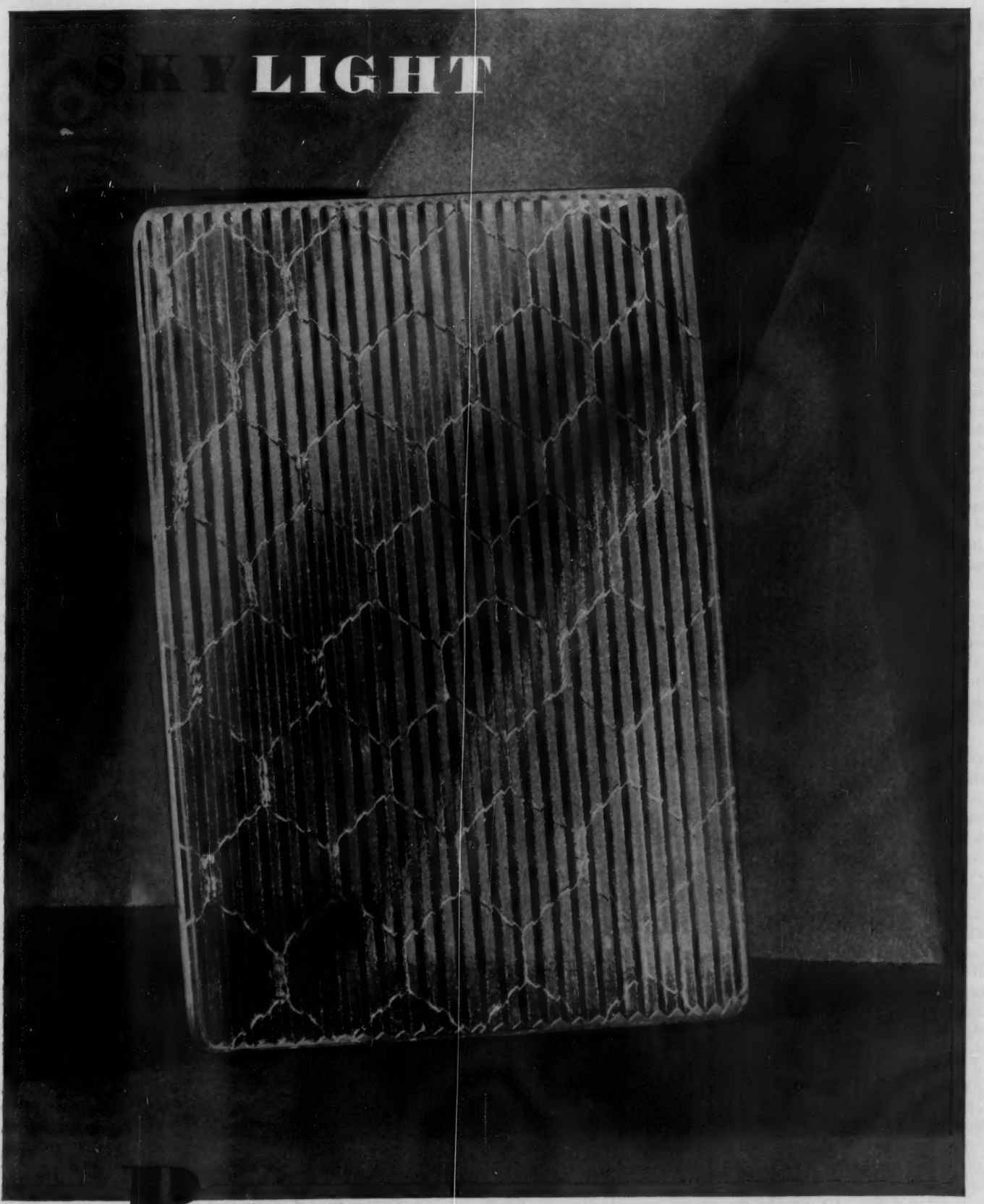


Trade-Mark Registered U. S. Patent Office

Made of extra quality cotton yarn, carefully inspected, and guaranteed free from all imperfections of braid or finish. The colored spots are our trade-mark, used only with this quality.
We make braided cord of all sizes, kinds, and colors, for all purposes, including sash cord, clothes lines, trolley cord, signal cord, arc lamp cord, and many special cords for special purposes.

CATALOGUE AND SAMPLES GLADLY SENT ON REQUEST

SAMSON CORDAGE WORKS : : 88 Broad Street, Boston 9, Mass.



PENTECOR . . . is a brilliant pattern, a combination of rib and prism specially made for use in skylights. It is easily installed and easily cleaned and may be obtained from glass distributors everywhere. (Plain or Wire Glass). Send for samples.

MISSISSIPPI WIRE GLASS CO. 220 FIFTH AVE. NEW YORK

Oil and Gas Well Fires

(*Continued from page 114*)

cubic feet of gas per day was burning at the time the photograph exposure was made, although the magnitude of the fire is not apparent because the burning gas presented little color to the camera. Special attention is directed to the stream of water above and flowing parallel to the diverter pipe. This water spray prevented the pipe from warping under the intense heat from the burning gas. The men working in the fire area were protected by water sprayed upon them.

The second or auxiliary diverter was made of a straight piece of 12½-inch casing. The inlet end was cut and shaped so that it would fit snugly halfway round the joint between the primary diverter and the well casing. Metal extensions or wings were welded to the secondary diverter to extend beyond the well casing when the diverter was snubbed into position. With the aid of a 4-inch steam jet directed between the wings, the auxiliary diverter removed gas at the rate of about 20 million cubic feet per day and the fire was extinguished within a few minutes. The total time required was slightly less than ten days, and the net loss was estimated as approximately $18,000. In addition to this monetary loss, more than 6 billion cubic feet of gas were wasted.

This fire probably was caused by rocks striking the steel of the derrick and creating sparks which ignited the gas. It must always be considered hazardous to blow a well into a steel derrick, especially where it is expected that great quantities of sand and rock will be thrown out. The flow may be directed outside of the derrick by installing a reducing-fitting equipped with a high-pressure gate valve on the master gate. A 30° or 45° high-pressure fitting should be attached to the smaller gate valve and a line run from it to a point outside the derrick. A 2-inch pipe should be attached to the valve stem of the master gate valve by means of a universal joint, and extended for a distance of 150 or 200 feet. With such a safety provision at the Shaffer Oil and Refining Co. well, the valve could have been closed safely as soon as the bridge had blown out instead of being allowed to blow for forty-five minutes and terminate in a fire. Under the conditions which existed, closing the gate would have been hazardous to the man attempting it, on account of the shower of rocks which issued from the well.

The Boviard and Atkins No. 1 gas well is located in Section 19, Papoose Oil Field, Okla.* The closed-in wellhead pressure was 1,175 pounds per square inch. When it was desired to take the well's production, all ordinary efforts to open the master-gate valve failed. A pint of nitroglycerine then was placed on the valve disk and set off. The result was fire.

The burning well, which was estimated as flowing at the rate of 50 million cubic feet of gas daily, was subsequently snuffed out by a charge of nitroglycerine.

A sand line was run over the crown block of a nearby rig and anchored to a deadman 20 feet beyond the burning well. The line passed within 2 feet of the well head. A water-jacketed shell containing 20 quarts of nitroglycerine was attached to the sand line by means of two running pulleys and was lowered down this inclined trolley by means of another line from the top of the same derrick which held the trolley line. When the shell reached a point within 2 feet of the mouth of the well, it was exploded by an electric current transmitted by previously attached wires, and the fire was extinguished. The time required was six hours.

It is evident that the wrong method was used in opening the master gate. It must be assumed that all usual methods and also many unusual methods were employed before explosives were resorted to. Judgment should be exercised when working on a master gate under high pressure to avoid violent jarring. In some cases a gate which is "frozen" may respond to heat. The expansion caused by playing a stream of steam against the body of the gate sometimes assists materially in opening it. Also the unbalanced pressure of 1,175 pounds per square inch on one side of the valve disk necessarily adds to the difficulties of opening it. Such a condition may be overcome by placing a reducing fitting and a small high-pressure gate on the downstream side of the valve, and by applying a pressure on top of the valve disk equal to the pressure on the upstream side. A more elaborate method consists in setting a second master gate on top of the first, and then installing a stuffing box on the upper gate, after which a drill could be inserted and the disk of the lower gate penetrated by the drill. If all such means fail and the use of explosives is finally resorted to, the explosive should be placed at the side of the valve and not on the disk. It is probable that two ounces of nitroglycerine exploded on the side of the valve just cited would have disrupted it with less danger of fire.

A description has been given of the methods of diverting oil and gas by means of penetrating the well casing at a distance below the surface; by placing various types of diverters over and around the mouth of the well; and by the use of explosives.

Various methods of smothering fires with steam, water, mud, carbon tetrachloride, and foam have been used at certain wells with success, although at other wells the magnitude of the fire defied such methods. Bowie* describes a gas well fire burning at the rate of 190 million cubic feet daily. Steam lines from twenty 50-horsepower boilers and water lines from thirteen pumps together with carbon tetrachloride failed to smother the fire, but the combination of these smothering media and the explosion of a charge of 150 pounds of dynamite suspended from a cable at the base of the flame, and 30 feet above the ground, extinguished the flame.

In conclusion, it should be pointed out that a great many oil and gas well fires are preventable if proper and well-known precautions are taken. After a fire is started, it becomes an individual problem and should be treated accordingly. The use of explosives is gaining favor.

It should be emphasized that attempts at extinguishing fires often fail on account of incomplete auxiliary preparations. Particularly, the surface of the ground surrounding the well should be cleared and soaked with water to prevent reignition of the fire after it is extinguished.

* Information concerning this fire was obtained from C. O. Rison, previously referred to.

* Bowie, C. P., Extinguishing and Preventing Oil and Gas Fires: Bull. 170, Bureau of Mines, 1918, p. 26.

A CORRECTION

We greatly regret the fact that the paragraph on page 59 of the March issue incorrectly describes the cover picture, "The Hudson River Bridge Under Construction," an etching by O. Kuhler. The view is one of the New Jersey tower of the bridge, with the New York tower and the east bank of the river in the distance. The bridge is to span the river from Fort Lee on the New Jersey side, to New York between 178th and 179th Streets.

A New Incandescent Lamp eliminates the difficulties caused by the black deposit which collects on the inner surface of high-powered lamps, cutting down the illumination and heating the glass so as to distort it.

The deposit is removed by means of a small amount of coarse tungsten powder in the lamp which sweeps across the glass when it is inverted and shaken slightly.

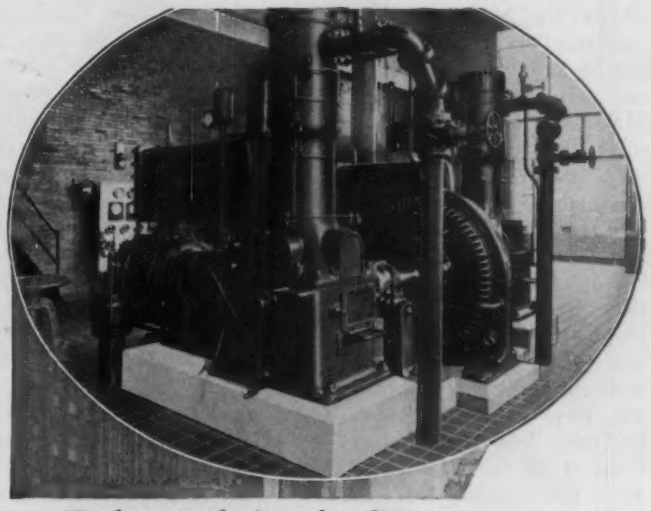
LABORATORY SUPPLIES

for Industrial Plants & Educational Institutions

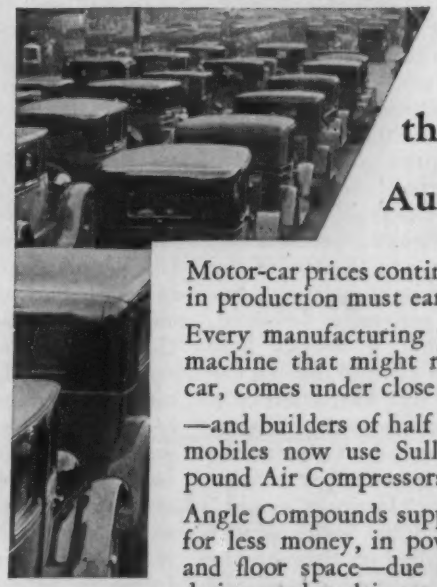
L. E. KNOTT APPARATUS COMPANY

Cambridge, Massachusetts

Leaders in Every Industry
Save Money with Sullivan Compressors



Balanced Angle Compressors Cut Costs on half the World's Automobiles



Motor-car prices continue to fall. Savings in production must earn the profits.

Every manufacturing process, and every machine that might reduce the cost per car, comes under close scrutiny—

—and builders of half the world's automobiles now use Sullivan Angle Compound Air Compressors.

Angle Compounds supply compressed air for less money, in power, maintenance, and floor space—due to balanced angle design, and multi-step control.

Some day you may be selecting air power for an industrial, mining, or construction enterprise. Remember Balanced Angle Compressors! They will give you—as they give leaders in every industry—most for your money in air power.

Sullivan Compressor Catalogs on Request

Where Production Savings Earn the Profits—Balanced Angle Compressors Help

An Opportunity for You

Every year the Sullivan Machinery Company picks a few graduates from schools like yours, for the sales and engineering staffs. If you are interested, send for booklet "Sales Engineering Opportunities."

SULLIVAN MACHINERY COMPANY
164 South Michigan Avenue
CHICAGO

Offices in All Principal Cities of the World

SULLIVAN TRADE MARK

Oil Geology and Production

(*Continued from page 91*)

regions had been studied and had given confirmation to accepted theories, but few areas had offered unusual phenomena. In Persia, Egypt and Tuxpan, Mexico, however, oil was found to be related to deeply buried limestone hills. Before burial the limestones were affected by the waters falling upon the old land surface, solution took place and pores and cavities were formed in them. Later, after new rock formations had covered the old hills, petroleum entered these cavities and reservoirs of oil resulted. These occurrences were interesting to American geologists, but were still upon a rather distant horizon. Not until the excellent conditions of the industry in 1925 combined with the scarcity of surface folds to encourage deeper drilling, were buried hills found to be of importance in the United States.

Deep drilling in Oklahoma, however, was not begun on a geologic basis. As with the early adventure of 1900 by Captain Lucas in Texas, the courage of unconventional opinion was needed. Heretofore in Oklahoma, drilling had been limited to depths of about 3,000 feet above a limestone bed called the Mississippi Lime. Contracts of lessors with the farmers always read that the drill should penetrate to the top of the Mississippi Lime, but in case of a dry hole the farmer generally believed, without reason, that a deeper hole would certainly have found oil. In the state, a mythical oil formation was famous and was known as the "Farmers' sand." However, in Tulsa a hay and grain dealer named Wilcox decided that possibly the "Farmers' sand" existed. He went down south of the Glenn Pool, and drilled on through the Mississippi Lime to find oil and the Wilcox sand, today one of the world's greatest oil producing formations.

Deep drilling in Oklahoma immediately was stimulated. In 1924 the Tonkawa field was drilled down to the Wilcox formation at about 4,000 feet. In 1926 the first of the great Seminole pools was discovered. Here at about 4,500 feet the Wilcox sand carried enormous reservoirs of oil and extraction was expedited by the adoption of the gas lift in place of the older plunger pumps driven by rods in the well. The gas frothing the oil permits the subterranean pressure to lift the lightened column in these deep wells to the surface.

In Oklahoma the deep production was found to be in connection with buried hills, but a second discovery of 1926 proved to resemble still more the petroleum fields of the foreign buried ranges. In West Texas pioneers had drilled at Big Lake and near the Pecos River. Great pools of heavy high sulphur oil were found in buried porous limestone ranges and at the latter place the largest oil field in the world was developed on the Yates Pool where high pressure on the oil would permit the largest production from a single well being obtained if the valves were opened wide. More recently deeper drilling was carried out at Big Lake, and in 1928, at 8,525 feet, the deepest oil well of the world was brought in flowing very high-grade petroleum.

In California also great depths had been reached and in 1926 new, deep oil formations at Long Beach were developed. In the area about Los Angeles, deep wells since that time at Rosecrans, Huntington Beach and Santa Fe Springs have contributed to the 150 million barrels yearly production of this part of California.

In addition to increasing petroleum production, deep drilling has had a marked effect on the organization of the companies. Surface folds have become of less interest in the developed areas and in Oklahoma little work upon the surface rocks is justified. The wells themselves are, however, studied with great care and the underground geology is known in great detail. Consequently the department of subsurface geology is today the principal unit in the oil company geological division. In turn the identification in the wells of the various beds has been the origin of a new department for the identification of the fossil remains extracted from the wells. Where identical fossil forms are found in different wells the same rock stratum is presumed to be present and as the material brought from the well is usually ground fine the microscopic forms are most useful. The micropaleontologist, has, therefore, become an important cog in the human machine of the modern oil organization. Geophysics is also being used and on the Gulf Coast seismographs and gravity measurements have led to the discovery of many salt dome pools. The technical study of oil occurrence has thus now extended to research in varied branches of science.

The highly trained, efficiently organized geological divisions of the oil companies, aided by the courageous pioneer, have carried oil production down to 6,000 feet in Oklahoma, to over 7,500 feet in California, and to the present maximum of 8,500 feet in West Texas. They have applied in recent years, in great detail with regard to local conditions, the more general theories of oil accumulation, origin and occurrence. The result is a yearly production from Oklahoma and California of over 200 million barrels of petroleum, each more than the total United States production in 1912, and a possible production in West Texas near the total of a year for the entire country, some 900 million barrels. The combination of knowledge and daring has proven too successful and for a period of the future the United States is faced with an oversupply of crude oil.

To meet this problem the oil industry has applied an unusual procedure. Within the states of Oklahoma and Texas, through agreements between the companies involved, each well is assigned a daily production "ration" by an umpire. New drilling is also limited. Production of the state is thus curtailed and a ruinous flood of oil prevented from reaching an already demoralized market. Within most states this arrangement is legal, but it has not as yet been generally applied. Under our federal laws regarding combinations in restraint of trade, it is impossible at present, throughout the United States, to curtail petroleum production by mutual agreement. To stabilize the industry, therefore, oil operators desire federal regulation of the nation's production of oil. It is possible that a board similar to the Interstate Commerce Commission may be proposed to assign to each state a ration as the state regulates the individual producer. Legislation of some corrective nature will no doubt soon be proposed, but the formula flair to producer, to consumer, and to the nation, the guardian of this great natural resource, has yet to be found.

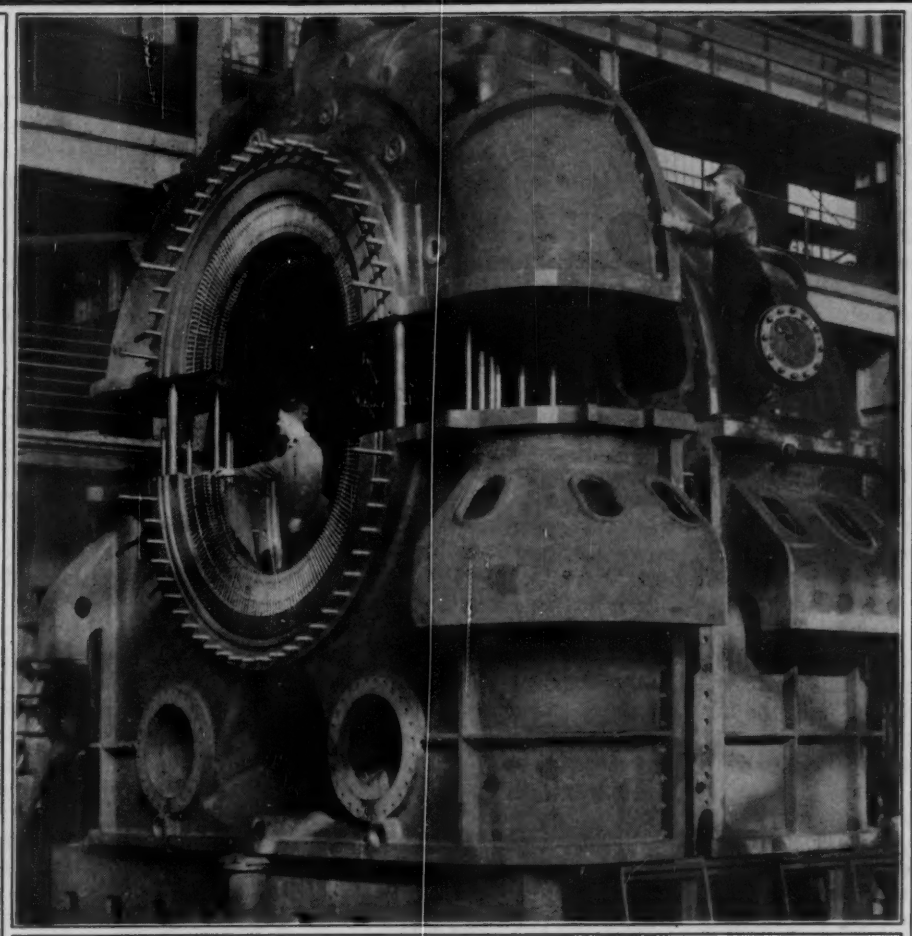
The attitude towards an irreplaceable natural commodity like petroleum should be one of conservation. In spite of the skill of geologists and their present intimate knowledge regarding oil occurrence, in spite of the unparalleled development of the industry with its constant succession of new fields from Titusville to Seminole and Yates, exhaustion of our petroleum reserves is inevitable in time. The nation must look to the future; it should endeavor to postpone as long as may be domestic exhaustion of crude oils and should coöperate with the petroleum industry fairly as its units are attempting today to coöperate among themselves.

Kilo-Man-Hours is a term suggested recently before the A. S. M. E. as a convenient unit by which to rate industry. But, because of the wide variation in results produced by an hour of labor, it was further suggested that "the ratio of the value of a product to a fixed unit of man hours of labor" be used instead.

P. G. ROBERTS,
Production Engineer,
Penn State, '25

C. W. GUTH,
Mechanical Engineer,
Colorado School of Mines, '22

ROBT. REYNOLDS,
Turbine Engineering,
Pratt Institute, '20



YOUNGER COLLEGE MEN
ON RECENT WESTINGHOUSE JOBS

E. F. STALCUP,
Headquarters Sales,
Kansas State, '21

C. E. WARE,
Contract Administration,
Penn State, '17

H. B. MAYNARD,
Manufacturing Operations,
Cornell, '23

The Duke Power Company Turbine-Generators

Where do young college men get in a large industrial organization? Have they opportunity to exercise creative talent? Is individual work recognized?

, , ,

THE largest steam-turbine generator units to be installed south of the Mason-Dixon line are now being built for one of the most unusual organizations of its kind in the world. The Duke Power Company is famous for the efficiency of its power plants—and for the fact that its profits are distributed largely to charity.

At a horseshoe bend in the Catawba River in the heart of the Piedmont Carolinas, the Duke Power Company is building a generating plant which, if present plans are carried out, will be the largest of its kind in the southeastern United States. The ultimate capacity will probably be 600,000 horsepower. The first two units, which Westinghouse is now building, each are to have a generating capacity of 55,000 kilowatts. They will develop 150,000 horsepower.

By operating at practically full capacity during the entire 24 hours of the day, letting the company's hydro-electric plants handle variations in the quantity of power required, the new units will reduce current costs to a minimum. , , ,

The large jobs go to large organizations. Westinghouse holds a strong appeal for young men of enterprise and genius because it almost daily provides contacts with outstanding developments in all branches of the electric field.

Westinghouse

Departmental Notes

(*Continued from page 102*)

of the product of two arbitrary functions, a step vital to the mathematical analysis of these line disturbances. The answer to this need was the first Integraph.

This machine was successful, and its use on other problems than that for which it was originated was encouraged. And here Fortune was at work, for these problems which were quickly forthcoming soon demanded a versatility in the machine beyond its capacity. At that point the first Integraph began to evolve; but its life was short. In a year and a half it was superseded by a second generation which had acquired the ability to integrate twice, as well as once, and even to anticipate the functions which it was to integrate. Improvements have been made continually to meet the problems that come to it, until today the machine stands ready to solve general forms of second-order differential equations in which the coefficients can be empirical relations, and even multi-valued or discontinuous in form.

The Integraph has been used not only by the students and staff of this department, but as well by members of other departments of the Institute, and by outside engineers and physicists. As an acknowledgment of the contribution which the Integraph represents to the science of computing machines, the Franklin Institute of Philadelphia a year ago presented the Levy medal to Dr. Bush and those research assistants who had been associated with him in the machine's development.

The success of the present Integraph has insured funds for further development, and active work has been under way for over a year on a third generation of this famous Robot family which will possess even superior capabilities, flexibility and accuracy.

The Integraph has stimulated work on the behavior of electrical machines in the transient state, for the equations which express the relationships involved are of complicated character. Having a machine to handle these equations graphically, time has been freed from complicated computations, and can now be devoted to more and deeper analysis. This has meant increased activity in machinery research, and to meet this interest a special machinery laboratory is being developed.

Among the major problems of large power system interconnections today are the transient oscillations which their synchronous machinery experiences when disturbed suddenly from normal operating conditions by faults or abrupt changes of load. The principles involved can be reasonably well developed upon machines of laboratory proportions; and the equipment in the Machine Transients Laboratory has been used to study aspects of this problem with good success.

This laboratory is being used also to support the classroom work in the graduate courses in electrical machinery by affording facilities not conveniently available elsewhere in the regular Dynamo Laboratory.

Extensive development of this Machine Transients Laboratory has been planned and should be under way within the coming year, with the General Electric Company coöperating in the project.

Visitors to the Research Laboratory frequently comment upon the great use which is made here of models; and it is not a surprising observation after seeing artificial transmission lines, both three-phase and single-phase, artificial power cables, an artificial submarine cable, and miniature generating stations and power networks. All of these, of course, are models in an electric sense only, behaving like their prototypes in terms of volts and amperes, but in no way resembling them in their physical appearance.

In the third project of the laboratory, the Alternating-Current Calculating Table which is now under construction, this representation in miniature is made possible on an extensive scale. By means of it, power system networks of interstate proportions can be conveniently represented as an intricate interconnection of artificial generating stations, transmission and distribution lines, and the dependent loads. Although power systems are generally polyphase, their representation on the table is made single-phase with the proportionality of reduction such that 200 volts and 0.5 ampere, which are taken as 100 per cent quantities, are equivalent to the rated phase volts and amperes of the actual system being studied. With connections which are equivalent to those of the real system, it is relatively simple to investigate such problems as voltage and power factor control, the effects of additional loads or tie lines, and the conditions attending short circuits and system disturbances. These conditions are duplicated in the table connections, and the resulting current, voltage and power measurements made directly by the insertion of the necessary instruments at the stations or loads.

This Alternating-Current Calculating Table, in the construction of which the General Electric Company is cooperating, will be the first of its kind, but once its feasibility is demonstrated there will be, no doubt, similar tables patterned after it by the larger operating or consulting groups. Already representative members of these groups are awaiting our development, and have asked to be favored by early trials of the device on problems typical to their interests. On the other hand, as the expense of such a table will be somewhat of a deterrent to its duplication by smaller groups, the Research Laboratory will be able to render a real service to these by the use of the table on outside problems in addition to its use in instruction and organized research.

M. F. Gardner '24.

PARAMOUNT PERFORMANCE
CHARACTERIZES ALI
LUFKIN
TAPES — RULES — TOOLS
Illustrated here is the "Rapid Reading" feature now to be found on all our Micrometers. It makes reading quicker, easier and more positive
LET US TELL YOU MORE ABOUT THIS AND OTHER EXCLUSIVE LUFKIN FEATURES
THE LUFKIN RULE CO.
WINDSOR, CANADA SAGINAW, MICHIGAN NEW YORK CITY

A new Jenkins Bronze Valve with resilient Jenkins Disc for steam pressures to 250 lbs.

Fig. 801
Jenkins Bronze Globe Valve, screwed, for 250 lbs. steam.

Traditions—
in college and in business

At every college, long-standing traditions are part and parcel of a student's life. Campus customs and campus ceremonies have a profound effect on the characters of students and graduates alike.

The effects of long-standing traditions are noticeable in business organizations, too. The Jenkins tradition, established in 1864, demands that valves be made for the maximum service not merely the average, and that standards of manufacture should be maintained at the highest level.

The effects of this tradition are apparent in the reputation of Jenkins Valves and the favor they find with consulting and operating engineers throughout the country.

Send for a booklet descriptive of Jenkins Valves for any type of building in which you may be interested.

JENKINS BROS.
80 White Street ..... New York, N. Y.
524 Atlantic Avenue ..... Boston, Mass.
133 No. Seventh Street .. Philadelphia, Pa.
646 Washington Boulevard .. Chicago, Ill.
JENKINS BROS., LIMITED
Montreal, Canada London, England

Always marked with the "Diamond"
Jenkins Valves
SINCE 1864

FASTER PRODUCTION
means still LOWER COSTS *to the* CONSUMER

The BROWN & SHARPE
AUTOMATIC ROD MAGAZINE
provides increased net production through a substantial saving of the operator's time

ALTHOUGH the average person seldom realizes it when he buys a serviceable clock, safety razor, or any of thousands of articles in daily use, his thanks for their low cost are partly due the Brown & Sharpe Automatic Screw Machines. Their ability to keep costs down lies in their automatic operation and the rapidity with which they produce accurately formed parts.

And now, to further increase the production and to make the cost still lower, the Brown & Sharpe Mfg. Co. has developed the Automatic Rod Magazine. It consists of a bar stock magazine with an arrangement for advancing the rods to the machine as they are needed. The operation is entirely automatic, thus the operator can care for more machines and the time required for restocking is reduced to a negligible amount.

We are always ready to send descriptive material covering the Rod Magazine and the Brown & Sharpe Automatic Screw Machines to any student engineer who is interested. It will pay you to become familiar with the equipment that holds so important a place in modern manufacturing.

BROWN & SHARPE
BROWN & SHARPE MFG. CO. PROVIDENCE, R. I., U. S. A.

Engineering and M. I. T.

(*Continued from page 92*)

steam was a source of great energy, a new era was entered upon which, starting with the Industrial Revolution, has developed into what the economists have called the "Machine Age."

The great developments in the automobile, the airplane, and electrical steam, light and power, and transportation industries are but practical instances of the direct application of the mechanical engineer's training. Because of this vast field wherein he can apply his talents, there is perhaps a greater demand for mechanical engineers than is common in most professions.

The courses of instruction given in mechanical engineering include considerable laboratory work to supplement lectures and recitations, for in no profession are theory and practice more closely allied.

Four special options are offered in the senior year. A student may, in place of these options, take a more general course in the fourth year if he does not desire to specialize so closely in some phase of mechanical engineering.

If the student wishes to take work in the options he may elect automotive engineering, which concerns a study of the principles of the construction and operation of automobiles and other self-propelled vehicles. Another option is known as engine design, and deals in detail with the design and development of motors, ranging from the fast types used in airplanes and dirigibles to the slow, sturdy and reliable engines required for the propulsion of ships. A third option deals with textile engineering and specializes both in the study of the fibre and in the study of the complicated automatic machinery which produces modern fabrics from their raw materials.

The modern practice of Electrical Engineering is the outcome of discoveries which began many centuries back, but which became particularly notable since the beginning of the Nineteenth Century when Sir Humphrey Davy, Oersted, Ampere and Faraday made a great series of researches and discoveries in electricity and magnetism. Inventors soon began to apply these discoveries in the arrangement of dynamos, electic lamps and telegraphy. The discoveries and inventions have continued at an increasing rate down to the present time.

The Institute's instruction in electrical engineering comprises study in designing, manufacturing, constructing, operating and research in the fields of application of electric circuits, machinery and apparatus. Electric lighting and heating, electric power production, electric transmission and distribution of power, electric railroads, telephony and telegraphy (by wires and radio), radio communications of all kinds, in addition to the designing and manufacturing of electrical machinery and appliances, are some of the fields of application.

None of the manufacturing industries is entirely unconcerned with the problems of chemistry. Whether the manufactured product is shoes or cement or paper, there is always a raw material to be analyzed, a process, whether simple or complex, to be controlled, and a finished product to conform to certain specifications. With the mounting realization of the importance of chemical constitution in all industrial processes, the sphere of the chemical engineer broadens, and broadens rapidly. The chemical engineer may accordingly be defined as an engineer engaged in the design and maintenance of the processes in which chemistry is applied on an industrial scale.

The course in Chemical Engineering established at the Institute is the oldest in the country, and its methods of instruction are based upon long experience in pioneering. In the training of the chemical engineer emphasis must of necessity be placed upon chemistry For the first three years the student is studying essentially the same courses which engage the attention of the chemist.

In all branches of industry, one of the most important phases of engineering is the utilization of heat and the generation of power.

The purpose of the Institute's course in Fuel and Gas Engineering is to train men in the solution of the complex problems incident to fuel utilization and processing. Since these problems are essentially of an engineering nature, specialization in this field demands a thorough preliminary training. Therefore the course has been planned as advanced graduate study for men who have completed an adequate undergraduate course in engineering or chemistry.

During the past sixty years the population of the United States has increased threefold; during the same period production of coal has increased thirtyfold, of pig iron fortyfold, of copper and lead fiftyfold and of petroleum three hundredfold. The mining engineer and metallurgist supply the greater part of the raw materials of construction and thus occupy a fundamental position in the structure of civilization and industry. The whole world is searched for its natural resources, the ores and minerals extracted and rendered available for the use of man. The field of the mining and metallurgical engineer is constantly broadening and continually calling for trained men. The work of the Department of Mining and Metallurgy is divided into four divisions: mining engineering, petroleum production, production metallurgy, and physical metallurgy. The courses of study are planned to give the student sound training in the sciences and their application in the related branches of mechanical, civil and electrical engineering.

The conquest of the air has been the dream of all the ages, but the final victory came, not by dreaming, but by harkening to the teachings of science. The work of the aeronautical engineer today consists essentially in the application of the fundamental

(*Continued on page 124*)

THE TEST of an Engineering plan is its adaptability to the purpose for which it was designed. Training for Institute work is an important engineering problem. The success of our many students after entering the Institute is due to their adaptability to Institute requirements and proves the thoroughness of our methods.

CHAUNCY HALL SCHOOL

553 BOYLSTON STREET, BOSTON, MASS.

FRANKLIN T. KURT, Principal

MATHEWS FIRE HYDRANTS

CAST IRON PIPE

Sand Spun or Sand Cast for Gas and Water

FITTINGS

Gate Valves and Boxes

Hydraulic Tools, Valves Fittings

Gas Producers

Gas Machinery

FOUNDRIES AND WORKS, FLORENCE, NEW JERSEY

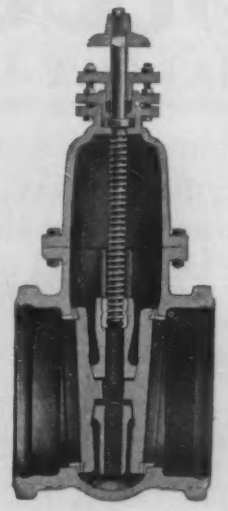
THE "MATHEWS" FIRE HYDRANT dates back to the late sixties, when Hydrants were largely the product of local foundries and the designs many and varied.

"MATHEWS" immediately gained favor and rapidly became the STANDARD for COMPARISON.

Today, with over three hundred thousand in service, it occupies first place, and the long list of users is constantly growing.

Our long experience has brought steady improvement in the details of construction, but because of the fundamentally sound principle there has been no radical change in the essential features of design. Correct design and substantial construction account for the success of the "MATHEWS" Hydrant.

We extend an invitation to all interested students to visit our extensive plant to observe the manufacture of "MATHEWS" Hydrants, and our other products.



CAST CENTRIFUGALLY IN SAND MOLDS

R. D. WOOD & COMPANY

Engineers, Iron Founders, Machinists

PHILADELPHIA, PENNSYLVANIA

Engineering and M. I. T.

(*Continued from page 122*)

principles of science to the particular problems of aeronautics. For this reason, therefore, it is necessary that the aeronautical engineer should first of all be trained thoroughly in these fundamental principles. This may well require more than half the length of a four-year engineering course. Mathematics, physics and chemistry are the three essentials. To mathematics the aeronautical engineering student must be prepared to give particular attention, for there is probably no branch of engineering where a good working knowledge of mathematics is more necessary than it is in dealing with aeronautical problems.

For the graduate student who wishes to continue his work after he has received his bachelor's degree, courses are offered in airship design, in the application of advanced methods to airplane design, in the design and testing of aeronautical engines, in air transport problems, in advanced research methods, and in recent developments of the mathematical theories of aeronautics. The work of the graduate years is largely elective, and a considerable part of the student's time is spent in original investigation and research.

A certain number of students of science possess interests sufficiently broad to make it unwise for them to specialize too closely in any one of the specific branches of science and engineering which the Institute offers. For the benefit of these, the Institute provides a general course of studies in a number of separate but closely interrelated subjects.

Administrative Engineering is one of the most recently developed branches of engineering. In spite of its youth, however, it is one of the largest and most important fields in which the basic principles of engineering can be applied. Engineering Administration simply means the application of the fundamental laws of engineering and applied science to the problems of management and production in industry — in short, it is scientific or systematized management.

Architecture is the oldest of the arts. Its monuments are the glory of the ages. Modern architectural problems call for modern solutions, but the principles that characterize good design and sound construction have not varied during the centuries, and are as vital a necessity in our modern life as ever they were in the past. An analytical study of the past as the best guide to the future must be the keynote for the proper study of architecture.

This breadth of study is of particular value to the student who enters the Institute directly from high school. The course extends over five years and leads to the degree of Bachelor in Architecture.

For those who are interested in Architectural Engineering rather than architectural design, a separate course is offered. It is devoted to a study pertaining to the construction of a building. Technical courses in this field are supplemented by courses in architectural history and in planning principles.

The building industry is among the greatest of all industries and, in its many ramifications, penetrates into nearly every department of human endeavor. As a field of opportunity it is almost limitless, for it embraces with its comprehensive folds all of the arts and all of the crafts and extends a welcome to men of every kind who have talent and initiative and ability. The art of building is comprehensive. It engages the attention of the architect and the engineer, the worker in stone, in iron, in bronze, in wood. It is the

(*Continued on page 126*)

Steel Sheets

THAT GIVE MAXIMUM RUST-RESISTANCE!

Highest quality steel sheets for the engineering, railway, industrial and general construction fields. This Company is the largest and oldest manufacturer of Black and Galvanized Sheets, Keystone Rust-resisting Copper Steel Sheets, Tin and Terne Plates adapted to all known uses. Sold by leading metal merchants.

The products of this Company represent highest standards of quality and service. *Made right—sold right.*

CONTRIBUTOR TO
SHEET STEEL
TRADE EXTENSION COMMITTEE

AMERICAN

STEEL SHEETS *for* Every Purpose

DISTRICT SALES OFFICES: Chicago, Denver, Detroit, Cincinnati, New Orleans, New York, Philadelphia, Pittsburgh, and St. Louis. Write nearest Sales Office for information and booklets.

Manufactured by

American Sheet and Tin Plate Company

General Offices: Frick Building, PITTSBURGH, PA.

SUBSIDIARY OF

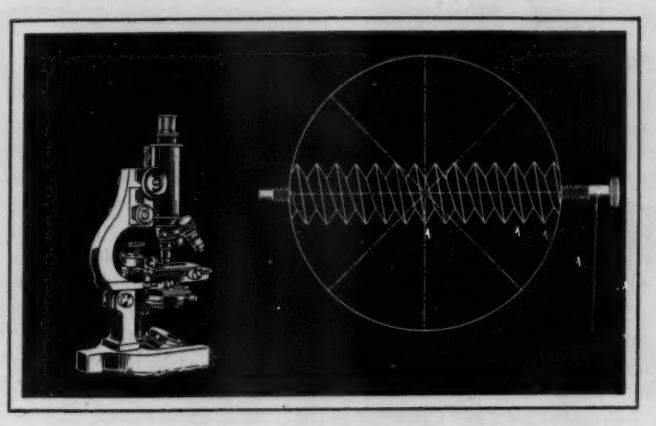
UNITED STATES STEEL CORPORATION

Quality Products — *Dependable Service*

PRINCIPAL SUBSIDIARY MANUFACTURING COMPANIES:

AMERICAN BRIDGE COMPANY
AMERICAN SHEET AND TIN PLATE COMPANY
AMERICAN STEEL AND WIRE COMPANY
CARNEGIE STEEL COMPANY
CYCLONE FENCE COMPANY
FEDERAL SHIPBUILDING AND DRY DOCK COMPANY
ILLINOIS STEEL COMPANY
MINNESOTA STEEL COMPANY
NATIONAL TUBE COMPANY
THE LORAIN STEEL COMPANY
TENNESSEE COAL, IRON & R. R. COMPANY
UNIVERSAL PORTLAND CEMENT COMPANY

Pacific Coast Distributors—United States Steel Products Company, San Francisco, Los Angeles, Portland, Seattle, Honolulu. *Export Distributors*—United States Steel Products Company, New York City



"How *can* I *best inspect precision tools?*"

A manufacturer said to us: "I must measure a number of templets frequently. Great accuracy is imperative. An optical method may speed up the process . . . " The B. & L. Toolmakers' Microscope—used in many other industries—was the simple solution to this problem.

In every phase of industry special optical instruments are solving problems of inspection and production control better and more economically. Bausch & Lomb scientists have studied many industrial fields. Their experience may be invaluable to you. Call on them.

BAUSCH & LOMB OPTICAL CO.

635 St. Paul St. Rochester, N.Y.

NOW !

NEW MALLORY HATS FOR SPRING

Choice Black Dawn (Gray) or Monaco Burl (Brown) shades at $7.50.

Choice Pelican or Walnut Filbert shades at $6.50

Lightweight Crushes

Choice Black Pelican (Gray) or Walnut Java (Brown) shades at $8.50.

NEW MODEL

MALLORY BLACK DERBY at $7.50

Look at your hat—Everybody else does.

MEN'S WEAR

TECHNOLOGY BRANCH, H. C. S.

76 MASSACHUSETTS AVENUE

IF MILLIONS DEPENDED UPON THE SHOT!

SUPPOSE you were planning a blast upon the success of which millions of dollars depended. Imagine the care with which you would select and test the materials and prepare the shot. You would do everything humanly possible to guard against a failure.

Did you ever stop to think that this is exactly our position in relation to the blasting caps we sell? The successful performance of many millions of dollars' worth of explosives depends upon the quality of the blasting caps and electric blasting caps that we supply to shoot them.

The care that goes into the manufacture of Hercules Detonators is out of proportion to their sales value. They mean much more to us than the profit from their sale. To us they represent additional insurance for satisfaction from the use of Hercules Explosives. Hercules Detonators furnish the same insurance to all who use them.

HERCULES POWDER COMPANY
(INCORPORATED)

941 King Street Wilmington, Del.

2653

Engineering and M. I. T.

(*Continued from page 124*)

object of the course in Building Construction of the Institute to meet this demand by supplying to the industry scientifically trained men, equipped with the mathematical and scientific knowledge of the engineer, with a thorough understanding of the technique of building and a knowledge of building finance and management, accounting, economics and industrial relations.

One of man's oldest means of transportation is the sea and shipbuilding has been one of the master arts from almost the beginning of time. The Department of Naval Architecture and Marine Engineering deals with two classes of students. The first comprises civilian undergraduates who are studying naval architecture and the art of ship construction as an applied science, or who are studying ship operating and the economics of the shipping business. The second group is made up of naval constructors, officers of the United States Navy, sent by the government for advanced instruction at Technology.

At the heart of all the engineering professions lies the science of physics. It should not, for this reason, however, be supposed that the study of physics is no more than a stepping-stone to some future accomplishment. Although the industrial physicist is relatively a newcomer in the ranks of scientific research workers, modern industry finds itself more and more in need of him.

The Institute's laboratories are large and well equipped, and furnish ample opportunity for the student to study phenomena in all branches of physics. Instruction is organized to permit students to specialize either in theoretical physics or its industrial applications. Many of its graduates enter the teaching professions. Others find occupation in the research laboratories of scientific institutions or large corporations. Wherever employment may be found, the graduate in physics may be sure of finding a steadily widening field of application for his work, in addition to the production of fundamental knowledge in the branch of science.

All material substances are composed of the chemical elements and the infinite variety of products available in the markets of civilization is the result of chemical transformation of raw materials obtained from the ends of the earth. The fascinating study of the interactions of the chemical elements and the many compounds to be obtained from them, the study of the physically important properties of these chemical substances and the applications of these properties to the beneficent use of man, is the pleasant problem of the chemist. The creation of a nation independent in its chemical resources during peace and war is a fascinating field for students with imagination and vision. The Chemistry course has been planned to stimulate the interest of the student in the satisfaction to be obtained in doing original thinking, creative work and producing new chemical knowledge with such broad vision that it may play a decisive part in new discoveries. In following such a fundamental course the student of chemistry will keep far in advance of the industrial applications of principles, and will, therefore, be in a position of great advantage.

The Institute has exceptional facilities for graduate work in the major branches of chemistry. Unexcelled facilities for further study of physical chemistry are found in the Research Laboratory of Physical Chemistry, which, founded in 1903, has been the training ground of a large number of prominent chemists now located in responsible positions in the educational institutions and industrial plants of the country.

Biology in a broad sense includes those sciences dealing with the study and control of living things, both plants and animals, from invisible microbe to man himself. Our food supply, clothing, leather, timber and paper are products of biological activity, and the great problems of health of communities through sanitation and control of diseases are questions of biology.

The field covered in the Department of Biology and Public Health combines in its courses the methods of the engineer, and the detailed study of the structure, behavior and control of living organisms and their activities. Training is thus offered to the student for a wide range of professional opportunities which are divided into two main groups. The first of these is public health and sanitation; the second is industrial biology.

Geology is the study of the science of the earth. It has many phases embracing the study of minerals and of the rocks which are made up of minerals. It includes the study of changes in the form of the earth's surface, the building of mountains, plains and deserts, deposition of sediments and changes in rocks. The manner of occurrence of ore deposits forms one of the practical applications of geology. The study of earthquakes and volcanoes is still another side of the science and one of much importance to mankind. The study of the history of life on the earth as shown by fossils in the rocks makes still another very different but very important part.

In order to equip men to start, upon graduation, in one phase of such broad applications of geological science, the undergraduate course in geology does not specialize, but gives rather a basic training in the science backed by adequate foundation in the fundamentals of mathematics, physics, and chemistry.

A graduate course is offered by the department to give to the advanced student opportunities to specialize in mineralogy, petrology (study of rocks), economic geology and paleontology (the study of fossils). A strong emphasis is placed on research work by graduate students, and such men will find encouragement during the progress of their work and in the publication of the results of their investigations.

Day by day man's knowledge and experience increases. He becomes better able to cope with his environment, to use and apply the principles and discoveries of science for the benefit of human welfare. To do this, is the privilege of the engineer, and, as the field of science widens, new branches and new opportunities open in the engineering profession. The Institute is keeping apace with these modern conditions. New courses are constantly under consideration, and every effort is being made to insure a technical training well qualified to maintain the high reputation of Technology, and the standards set by the achievements of the Alumni of M. I. T.

William G. Starkweather, M. E., Cornell '92 John B. Starkweather, B. S., M. I. T. '21

STARKWEATHER & BROADHURST
INCORPORATED

Engineers and Contractors for Power Plant Apparatus

79 Milk Street BOSTON HANcock 4530

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE, MASSACHUSETTS

THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY offers Courses in Engineering and Science, each of four years' duration, leading to the degree of Bachelor of Science in:

AERONAUTICAL ENGINEERING
ARCHITECTURAL ENGINEERING
BIOLOGY AND PUBLIC HEALTH
BUILDING CONSTRUCTION
CHEMICAL ENGINEERING
CHEMICAL ENGINEERING PRACTICE
CHEMISTRY
CIVIL ENGINEERING
ELECTRICAL ENGINEERING
ELECTROCHEMICAL ENGINEERING
ENGINEERING ADMINISTRATION
GENERAL SCIENCE
GENERAL ENGINEERING
GEOLOGY
INDUSTRIAL BIOLOGY
MATHEMATICS
MECHANICAL ENGINEERING
METALLURGY
MILITARY ENGINEERING
MINING ENGINEERING
NAVAL ARCHITECTURE AND MARINE ENGINEERING
PHYSICS
SANITARY AND MUNICIPAL ENGINEERING

Five Year Courses

The Course in Architecture is of five years' duration, and leads to the degree of Bachelor in Architecture. Five year Coöperative Courses in Electrical Engineering and Railroad Operation leading to the degrees of Bachelor of Science and Master of Science are also offered.

Graduate Courses

Leading to the degrees of Master of Science, Master in Architecture, Doctor of Philosophy, Doctor of Science and Doctor of Public Health are offered. The Courses leading to the degree of Master of Science include Coöperative Courses in Chemical Engineering Practice and Fuel and Gas Engineering.

The Better High Schools

And other preparatory schools in the United States offer adequate preparation for the required entrance examinations given by the College Entrance Examination Board in June, or by the Institute in September.

Graduates of Colleges

Or of scientific schools of collegiate grade, and in general all applicants presenting satisfactory certificates showing work done at another college corresponding approximately to at least one year's work at the Institute, are admitted to such advanced standing as is warranted by their previous training, and are given credit for our required subjects, including the entrance requirements, so far as they have been satisfactorily completed.

The Summer Session

Extending from June to September includes most of the subjects given during the academic year and in addition special courses for teachers.

Any of the following publications will be sent free upon request:

CATALOGUE FOR THE ACADEMIC YEAR (which includes the admission requirements)
SUMMER SESSION CATALOGUE
GRADUATE STUDY AND RESEARCH

Correspondence should be addressed to the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Closed—the Road to Waste

INDUSTRY of the old school faced Waste as a necessary evil.

But now there is a *new school,* the modern, which employs new weapons to fight friction, maintain alignment, save power and preserve enduring machine life.

The coming generation of engineers and potential Captains of Industry are provided with the world's greatest weapon against Waste—Timken Bearings.

There is scarcely a single student of applied mechanics and economics who does not know Timken Bearings—and the exclusive combination of Timken tapered construction, Timken *POSITIVELY ALIGNED ROLLS* and Timken electric steel.

These graduates of the modern school are going out on the Highway of Life. They are going prepared to Close the Road to Waste with Timken Bearings, wherever wheels and shafts turn.

THE TIMKEN ROLLER BEARING CO.
C A N T O N , O H I O

TIMKEN *Tapered Roller* **BEARINGS**

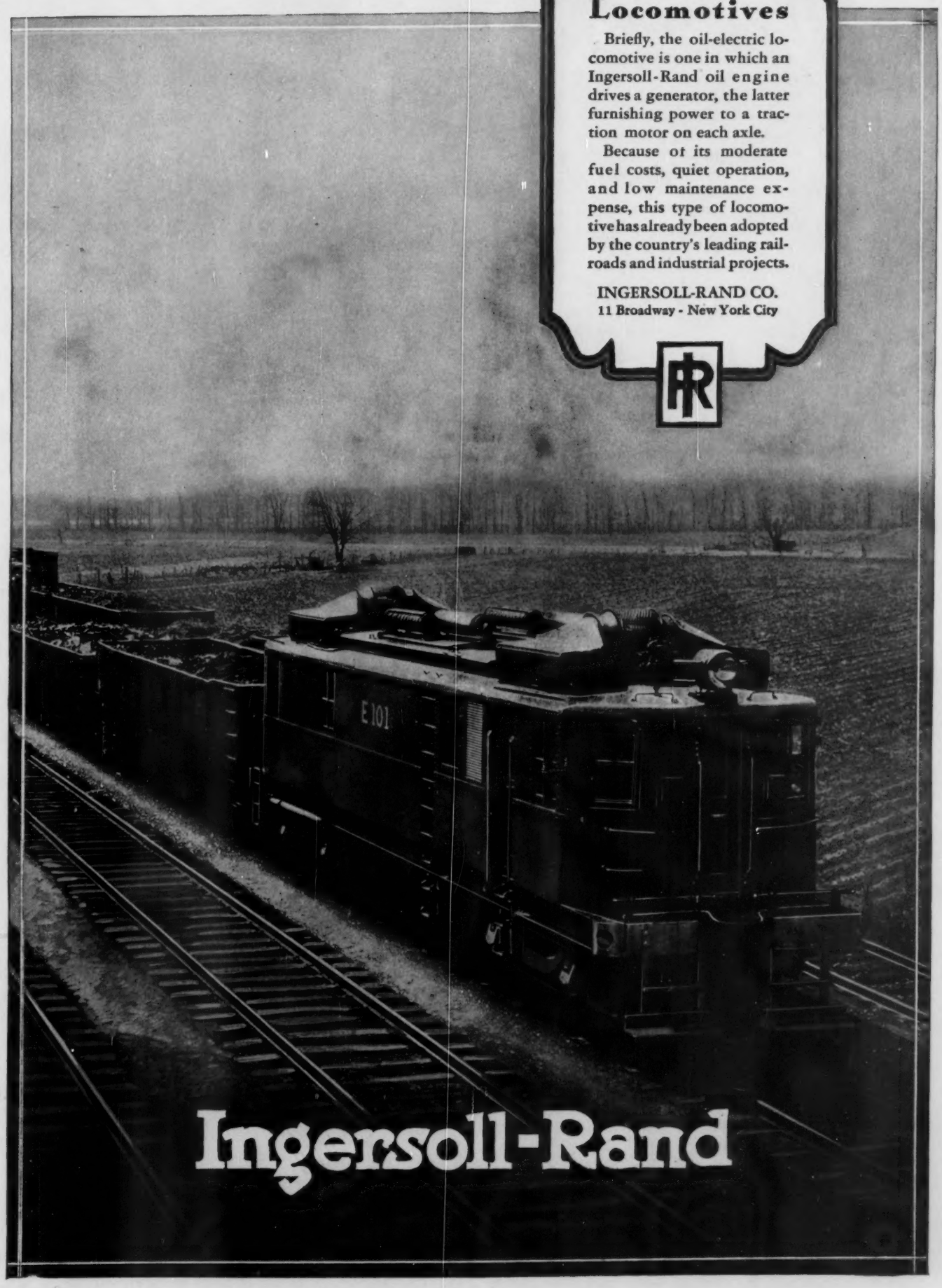
THE TECHNOLOGY PRESS, CAMBRIDGE, MASS.

Locomotives

Briefly, the oil-electric locomotive is one in which an Ingersoll-Rand oil engine drives a generator, the latter furnishing power to a traction motor on each axle.

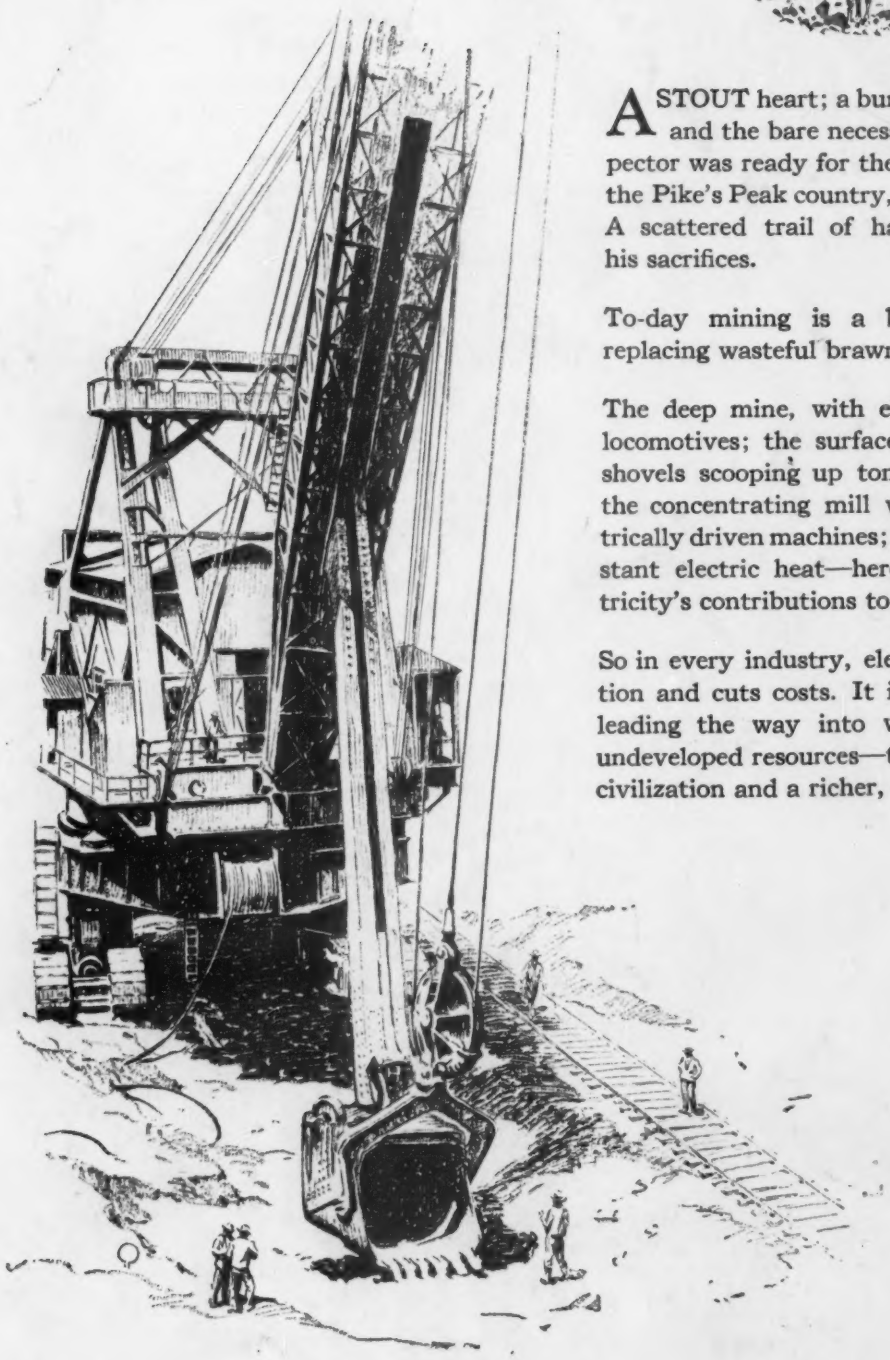
Because of its moderate fuel costs, quiet operation, and low maintenance expense, this type of locomotive has already been adopted by the country's leading railroads and industrial projects.

INGERSOLL-RAND CO.
11 Broadway - New York City



ELECTRICITY—

the modern prospector



A STOUT heart; a burro laden with pick, shovel, and the bare necessities of life; and the prospector was ready for the gold rush—Sutter's Mill, the Pike's Peak country, Cripple Creek, Klondyke. A scattered trail of half-worked claims marked his sacrifices.

To-day mining is a business, with electricity replacing wasteful brawn in mine and mill.

The deep mine, with electric lights, hoists, and locomotives; the surface mine with huge electric shovels scooping up tons of ore in a single bite; the concentrating mill with its batteries of electrically driven machines; the steel mill with its constant electric heat—here are but a few of electricity's contributions to the mineral industries.

So in every industry, electricity increases production and cuts costs. It is the modern prospector, leading the way into wider fields and tapping undeveloped resources—that we may enjoy a finer civilization and a richer, fuller life.

You will find this monogram on powerful motors that drive heavy mining machinery and on tiny motors that drive sewing machines. Both in industry and in the home it is the mark of an organization that is dedicated to electrical progress.

95-658DH

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, NEW YORK